“Community of Interests”

The Creation, Development and Challenges of the Science Faculty at the University College of Swansea, circa 1920 – 1970

A Dissertation for the Degree of Doctor of Philosophy

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Abstract

This thesis addresses the development of the science faculty at the University College of Swansea from its creation in 1920 to 1970 through the progression of the science departments, the scientific curriculum, and research. While the timeline of the thesis is concentrated in the twentieth century, there is an initial investigation into nineteenth century university curriculum reform to clarify the link to later scientific educational developments and academic relationships with industry and commerce. This thesis argues that it was a framework of communities with its attendant roles of collaborations and networks which supported and shaped academic development both within the institution and in external spaces of influence. The expansion of these communities enabled the growth of the institution's industrial, commercial, and academic connections at a regional, national, and transnational level. At the core of this research is the previously uncatalogued primary source material which provided an invaluable insight into decades of challenges, reactions, and relations of the individuals of the science faculty's communities. Furthermore, to place the institution's academic developments in a wider historical context an interdisciplinary approach was taken using the fields of educational, industrial, and cultural histories accompanied by political and military studies. By using this approach, the thesis determines how well the university college adapted to the challenges of delivering a comprehensive programme of science modules during adverse financial and unfavourable political periods, notably the depression of the 1930s and World War II. In addition, the thesis asserts that the post-war modernisation of the science faculty's infrastructure was an essential element in ensuring that the University College of Swansea responded positively to the demands of delivering modern academic scientific teaching and research.

Declarations and Statements

DECLARATION

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed

Date

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed

Dated

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed

Dated

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Acknowledgements

Without the award of a scholarship by the College of Arts and Humanities at Swansea University, this thesis would not have been written. Therefore, I am grateful to the college for financial support which presented me an opportunity to research the early history of an institution that educated and gave me the space to grow as a historian.

That education began with the Department for Continuing Adult Education (DACE) at Swansea University. Following six years of part-time study, I obtained a first-class BA (Hons) in History. I was encouraged to continue my studies at postgraduate level, and with the guidance of my MA supervisor Dr Christoph Laucht, and my MA lecturers, my skills were honed as a researcher which gave me confidence to undertake this thesis. I am extremely grateful to both Dr Christoph Laucht, who has continued to assist me as my first supervisor, and Dr Tomás Irish, my second supervisor. For over three years they have guided me with patience and understanding, and their expertise has proved invaluable in taking my research beyond the borders of Wales.

In addition to my supervisors, individuals from the community at the History department at Swansea University, both academic and administrative, have been supportive and available for discussions and advice. I am appreciative of the conversations with numerous past scientists and technical staff of the university, especially for their scientific knowledge. The memories captured by my colleague, Dr Sam Blaxland, in his oral histories of the university have also proved useful. I am grateful to him for his generosity in giving access to his research, as I am for the time given by my colleague and PhD researcher, Jay Rees. Also, a heartfelt thanks is given to Professors John Tucker (Department of Computing), Caroline Franklin (Department of English), and Mike Charlton (Department of Physics) for numerous conversations on the bigger picture and their hospitality.

At the centre of this thesis is the archive collection of Swansea University, and for that reason the Richard Burton Archives at Swansea University became my second home. So, I express my gratitude and thanks to the archivists and staff, Sue, Katrina, Stephanie and Stacey for their expertise and support. With that in mind I would like to give special thanks to Emily Hewitt who went that extra mile in assisting me with archival conundrums! In addition, I am sincerely grateful to the library staff at the Singleton

Campus of the Swansea University, who were always willing to support me in numerous ways. I am appreciative of the help of librarians and archivists at numerous other institutions including: West Glamorgan Archives, Swansea, South Wales, Miners Library, Swansea Museum, South Wales Miners Library, National Library of Wales, Aberystwyth, Special Collections and Archives, Cardiff University Library. Special appreciation goes to Heather Pardoe, Professor Christopher Cleal and Anita Holmes of the National Museum of Wales for their efforts in locating interesting material and sharing their findings.

The line of my research took me beyond the institutions of Wales, and I sincerely thank the archivists at the University of Manchester, the University of Sheffield and the Modern Records Collection, University of Warwick for their invaluable assistance and guidance in accessing their collections. My time at Sheffield was enhanced by my conversations regarding my research with Dr Heather Ellis of the University of Sheffield. In addition, my gratitude to the staff and archivists at the National Archives at Kew and the British Library for their practical help.

Finally, I want to give special thanks to all my family and friends for their support and understanding over the years. In particular, I am indebted to Joseff and Lauren for their continuous support and expertise during the past decade.

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Abbreviations

ARD	Armaments Research Department
AUT	Association of University Teachers
BAAS	British Association for the Advancement of Science
BISRA	British Iron and Steel Research Association
BLS	Bureau of Labour Statistics
CERN	European Organisation for Nuclear Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DSIR	Department of Scientific and Industrial Research
EISCAT	European Incoherent Scatter Scientific Association
ERP	European Recovery Programme
GDR	German Democratic Republic
GNP	Gross National Product
IAEA	International Atomic Energy Agency
IERE	Atomic Energy Research Establishment
ICE	Institution of Civil Engineers
ICI	Imperial Chemical Industry
IGY	International Geophysical Year
MLNS	Minister of Labour and National Service
OSRD	Office of Scientific Research and Development
RAE	Royal Aircraft Establishment
RAF	Royal Air Force
RISW	Royal Institute of South Wales
TNT	Trinitrotolvene

TRE	Telecommunications Research Establishment
UCL	University College of London
UCS	University College of Swansea
UGC	University Grants Committee
USSR	Union of Soviet Socialist Republics
YMCA	Young Men's Christian Association
ZETA	Zero-Energy Toroidal Assembly

Introduction

The foundation of the University College of Swansea connected the worlds of academic science and the heavy industries of South Wales. A link that was not easily perceived from the choice of site for the new institution. While observing the desirable location of the University College of Swansea in 1925 Sir William Ellis uttered a comment that alludes to a key reason for the existence of the institution,

> When at Singleton it is difficult to conceive one is really in the centre of one of the most important steel manufacturing centres not only in South Wales, but in the country generally! – because of the lovely location of the college.[1]

The institution's position in a region of metallurgical industries in South Wales was a crucial element in its foundation. This point of view was endorsed by the industrialist, Sir Alfred Mond, who stated in an address delivered at the Swansea institution that the impetus to establish a fourth affiliated college of the University of Wales during a difficult interwar period was driven by national and local concerns and ambitions for industry.[2] As well as having a commercial interest in the region, Mond was a liberal politician and a member of parliament for Swansea from 1910-1923.[3] Indeed, the region's industrialists had high ambitions for the new university college declaring that 'we expect it to become the Mecca of every student of metals.'[4] Equally, the siting of the university college at Singleton abbey in parkland and fronted by the coastal region of the Swansea Bay within close proximity to the Gower hinterland would prove to be of great benefit to the natural science departments. 'I doubt if any other university centre has such a wide variety of terrain so close at hand,' was how Professor Balchin, head of Geography described the institution's enviable location in his inaugural lecture in 1955.[5] The decision regarding the location of the fourth constituent college of the University of Wales was the beginning of a process that ensured the future

[1] Swansea Museum Library, Box no: 86, reference no: 78/24, *Swansea University College Engineering Society, vol. 1* (1925).
[2] Swansea University Library Pamphlets, Box no: T170 – TA399, reference no: T175, Sir Alfred Mond, *The Application of Science to Industry* (Swansea: Ernest Davies & Co., 1923), pp. 1-5.
[3] Hansard, *Sir Alfred Mond*, https://api.parliament.uk . Mond was an MP for the constituents of Swansea Town from January 17, 1910 – December 14, 1918, Swansea West, December 14, 1918 – November 15, 1922, Swansea West, November 15, 1922 – December 6, 1923.
[4] Richard Burton Archives, Swansea University Archive Collection, Box no: 664, uncatalogued bundle 1 of 2, *The Institute of Metals. Souvenir Swansea Autumn Meeting* (1922), p. 18.
[5] Swansea University Library Pamphlets, Box no: LF 1217, Inaugural Lectures 1947-1968, reference no: LF 1217.5.15, Professor W. G. U. Balchin, *Research in Geography* (1955).

establishment of the science faculty. Furthermore, the complexity of the interrelated factors that defined that development were central to the early survival of the University College of Swansea.[6]

Aims

This thesis is a historical study of the 'College in the Park', the University College of Swansea. The study focuses specifically on the creation and development of the institution's science departments of Biology, Chemistry, Geology, Physics and Metallurgy.[7] While it is recognised by historians of Welsh institutional history that the need to provide scientific teaching and research underpinned the decision to create a university college at Swansea, the thesis develops the argument beyond that traditional boundary.[8] By analysing recently catalogued primary source material directly connected to the university college, the thesis argues that the institution's history in its first 50 years was defined by its scientific research. In addition, the teaching and research requirements of a developing science faculty shaped the physical presence of the institution, which still define the modern campus at Singleton. While there is a focus on scientific academic endeavour and the achievement of a scientific academic reputation, the access to the primary source material allows an exploration into institutional difficulties. These are connected to the institution's foundation and the creation of its infrastructure, and are assessed through the themes of departmental space, finance, and staffing. Moreover, the thesis shows that the formation of the five science departments that constituted the science faculty encouraged the development of connections between industry, academia, and commerce to flourish and evolve from limited regional participation to national and transnational connections.

While the principal theme of the creation and development of the science faculty begins in 1920 the background to scientific debates and developments is essential context. The thesis connects the position of both pure and applied science in the

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[6] Mond, *The Application of Science to Industry*.
[7] The term 'College in the Park' was used quite often to advertise the university college's location, including the examples: 1) Student handbook, *College in the Park* (1951). 2) 'College in the Park plans Shrine for Science' *Reynolds News* (22 February 1959).
[8] J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997), p. 169. David Wilmer Dykes, *The University College of Swansea. An Illustrated History* (Stroud: Alan Sutton, 1992), pp. 66-7.

twentieth century academic space to its nineteenth-century roots.[9] Such an evaluation isolates the causes for the increasing relevance of academic science to the wider industrial, commercial and political worlds, and highlights the parallel growth of academic science and modernisation. In this context the thesis explores how pure and applied science became established on the nineteenth century academic curriculum. As well as engaging with the above-mentioned themes, the overarching objective of the thesis throughout the second and third parts of the study is twofold:

First the thesis will identify and measure how the construction and expansion of infrastructure underpinned and shaped the modernisation processes of the institution from its early beginnings through to 1970.

Secondly it will position the academic and research history of the science faculty of the Swansea institution beyond the regional confines of Wales and place them in the context of national and transnational narratives.

The aim of the latter approach to Welsh institutional history corresponds with the sentiment of the conclusion of Neil Evans' article in *Social History*, who stated that, 'the social history of Wales is too important to be confined to Wales and the Welsh'.[10]

At its foundation the University College of Swansea became part of a teaching and research community that was the federal system of the University of Wales.[11] While the thesis does not explore the institutional history of the parent body, the University of Wales, it does include aspects of science departmental histories of the three constituent colleges of Aberystwyth, Bangor, and Cardiff. These inclusions identify inter-college links and networks with the Swansea institution, as well as comparing science faculty constructions and science curriculum developments between the constituent colleges. There is discussion within the thesis that relates to the federal system, especially in connection with the constituent colleges' relationships with traditional and industrial communities throughout Wales. For instance, chapter two discusses at length aspects of the Welsh federal system and the decisions made by its administration. It is also important to place specific long-term problems of the Swansea institution in the context

[9] Michael Sanderson, *Education and Economic Decline in Britain, 1870 to the 1990s* (Cambridge: Cambridge University Press, 1999).
[10] Neil Evans, 'Writing the Social History of Modern Wales: Approaches, Achievements and Problems', *Social History,* 17 (1992), 479-492.
[11] Williams, pp. 137-39.

of competition and development within the federal system, notably college independence concerning the creation and development of science departments. There were other issues that were a preoccupation of the federal administration such as funding and staff salaries, and these are evaluated within the context of departmental progress of the science faculty at the Swansea institution. Furthermore, the final chapter addresses a period of crisis in the Welsh federal system's history and identifies the underlying causes of this internal institutional matter.

Yet, the development of the science faculty at the Swansea institution was more than just an institutional success story placed within the framework of higher education in Wales. The study investigates departmental developments primarily through the creation of scientific communities. These are explored not just within the academic and industrial spheres of activity at regional, national, and international levels, but within the political arena as well. The purpose of this approach is to show how, and to what extent academic scientists at the institution interacted with other scientists, departmental colleagues, and individuals working outside of the influence of academia. Furthermore, it is an opportunity to highlight the participation and contribution of less senior scientific, technical and support staff employed by the institution. In addition, the chapter argues that these members of staff were essential for departmental and institutional progress, as well as the success of research projects established by senior scientists.

Throughout the thesis a key term is the word 'community'. The main usage of the word can be identified as 'communities of interest' which describes the relationships formed within departments, as well as at an inter-departmental level. In addition, the phrase 'communities of interest' also applies to the close connections formed outside of academia with other interested partners such as industry. While the archival evidence reveals that the term 'community' is used, particularly in official documents, to loosely describe centres of industry and commerce, there is no evidence that the term is used by successive senior academics within the science faculty to describe their departments. Neither is the term used by the university college's registrar, Edwin Drew in his extensive correspondence dealing with the institution's matters. The one exception is a retrospection of Professor Mockeridge who described 'our college' as 'a community of

35 staff'.[12] As well as 'community of interests' the other term that is used later in the thesis is 'epistemic communities. As the scientific professions became increasingly interconnected at a transnational level and their associations progressively complex, this new concept of 'community' emerged.

The concept of 'epistemic communities' was defined by the political scientist Peter M. Haas as 'networks of knowledge-based communities with an authoritative claim to policy-relevant knowledge within their domains of expertise'.[13] Thereby, as the thesis identifies the increasing complexity of the industrial, and civic connections to the scientific community at the University College of Swansea in the latter part of the study, the term epistemic communities is used in those discussions. However, caution is applied in the research when looking at the concept of 'community', due to the numerous definitions of that abstract idea.[14] Theoretical discussions on the concept of community expanded during the nineteenth-century, with Ferdinand Tönnies' (1855-1936) seminal work, *Gemeinschaft und Gesellschaft* being a significant influence on sociologists.[15] Yet, the development of an increasingly complex society in Britain has challenged the traditional definition of community, which has now three recognised areas of usage; geographic communities, communities of interest and virtual communities.[16] Maurice Kogan asserts in a 2000 study that 'If its use has always been loose, it has become so promiscuous as to deprive it of meaning'.[17] Within this research the word 'community' is used in the traditional way to define a group of individuals who share a common profession, or collective groups with a shared professional purpose.

[12] Richard Burton Archives, reference no: Box no. 664, Professor F. A. Mockeridge, 'Retrospect' in *Dawn* (1954), pp. 4-5.
[13] Peter M. Haas, *Epistemic Communities, Constructivism, and International Environmental Politics* (London and New York: Routledge, 2016), p. 5. For further reading on epistemic communities, Peter M. Haas, 'Introduction, epistemic communities and internal policy coordination', *International Organization,* Cambridge Journals 46 (1992), 1-35.
[14] Colin Bell and Howard Newby, *Community Studies. An Introduction to the Sociology of the Local Community* (London: George Allen Unwin Ltd., 1975).
[15] Ferdinand Tönnies, *Community and Association (Gemeinschaft and Gesellschaft),* trans. by Charles P. Loomis (London: Routledge & Kegan Paul Ltd., 1955).
[16] Maurice Kogan, 'Higher Education Communities and Academic Communities' in *Higher Education and its Communities* ed. by Ian McKay (Buckingham: The Society for Research into Higher Education & Open University Press, 2000), 29-37 (p. 30).
[17] Kogan, p. 30.

Historiography

While this section assesses the historiography on themes connected to the establishment and development of the science faculty at the University College of Swansea, it also highlights problematic areas of this historiography. Notably, previous published accounts of the institution's creation and growth are limited and are placed within the institutional histories of the University of Wales and its constituent colleges. One exception is the institutional history of the University of Swansea by David Dykes which according to the author is only 'an historical sketch', yet it does address the institution's main departmental developments within the science faculty.[18] In contrast, by constructing the history of the science faculty within a framework of regional, national and international themes the thesis moves away from the narrative approach undertaken by Dykes. Yet, for the purpose of this research Dykes' identification of key political and industrial players in the institution's creation and development is helpful, as it is a recognition of the science faculty's senior scientists.[19]

The other scholarly works which address scientific curriculum and departmental developments at the University College of Swansea are restricted to accounts in histories of the University of Wales. Such institutional narratives are limited in number and were often a response to an approaching anniversary. They include *The University of Wales – A Historical Sketch* (1953) by Emrys D., Evans, *The University of Wales 1939-1993* (1997) by Prys Morgan and J. Gwynn Williams's *The University of Wales 1839-1939* (1997).[20] The first published work that documents the narrative of the Welsh University Movement was written by W. Cadwaladr Davies and W. Lewis Jones who both had first-hand knowledge of the movement.[21] The work of Davies and Jones is not directly relevant to the history of the Swansea institution due to its publication in 1905, however, it does include great detail of the early institutional histories of the three colleges of Aberystwyth, Bangor and Cardiff.[22] This 1905 study and other later institutional histories of the three constituent colleges provide a wider background to the

[18] Dykes.
[19] Dykes.
[20] Emrys D. Evans, *The University of Wales – A Historical Sketch* (Cardiff: University of Wales Press, 1953. Prys Morgan, *The University of Wales 1939-1993* (Cardiff: University of Wales, 1997). J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997).
[21] W. Cadwaladr Davies and W. Lewis Jones, *The University of Wales and its Constituent Colleges* (London: F. E. Robinson & Co., 1905).
[22] Davies and Jones.

narrative of the foundation of the University College of Swansea. Furthermore, institutional works such as J. Gwynn Williams 1985 study on the University College of Bangor, are of interest to the thesis as they highlight scientific inter-college links.[23] Yet, this area of the historiography of the University of Wales is only significant to this study to a point, as details of the academic links and relationships are limited in their reference to the Swansea institution.

While these institutional histories critically appraise the overall development of the University and its constituent colleges, there is rarely a mention of the University of Wales or its federal system within the historical context of university development in Britain. The side-lining of Welsh history of education in the British national narrative is discussed in the author's MA dissertation *Development and Discord in the Welsh Federal University Movement (1889-1914)* (2016).[24] However, there is one exception to this which is the 1972 research on the relationship between universities and British industry by Michael Sanderson, which dedicates a chapter to the Welsh universities movement between 1850 and 1914.[25] However, Sanderson's generalization that historically there was a dearth of 'great men of science' in Wales is contestable.[26] Other works by Sanderson are referred to in the thesis and include his 1999 publication in which the connections between education and the economic health of the nation are explored, which is an area of scientific history that is tackled in the thesis.[27] Furthermore, the timeline of Sanderson's works and his edited book, *The Universities in the Nineteenth Century* cover the period of nineteenth century educational reform, of which curriculum reform is fundamental to this work.[28]

[23]J., Gwynn Williams, *The University College of North Wales: Foundations 1884-1927* (Cardiff: University of Wales Press, 1985). Other published university college histories include, Gwyn Jones and Michael Quinn, *Fountains of Praise. University College, Cardiff, 1883-1983* (Cardiff: University College Cardiff Press, 1983). Edward Lewis Ellis, *The University College of Wales, Aberystwyth* (Cardiff: University of Wales Press, 1972).
[24] Karmen Thomas, *Development and Discord in the Welsh Federal University Movement (1889-1914)* (University of Swansea, 2016), p. 2.
[25] Michael Sanderson, *The Universities and British Industry 1850-1970* (London: Routledge & Kegan Paul, 1972).
[26] For further information on historic Welsh scientists see, T. Iorwerth Jones, 'The Contributions of Welshmen to Science' in *The Transactions of the Honourable Society of Cymmrodorion,* session 1932-33 (London: Issued by the Society, 1934. While this study details only brief biographies it does include lists of published research papers of the scientists. Another source that highlights scientific historical figures is compiled by the Welsh Government, *Welsh Achievements in Science, Technology and Engineering,* https://businesswales.gov.wales/innovation/news-0/welsh-achievements [accessed 22 October 2019].
[27] Sanderson, *Education and Economic decline in Britain, 1870 to the 1990s*.
[28] Michael Sanderson, ed., *The Universities in the Nineteenth Century* (London and Boston: Routledge & Kegan Paul, 1975).

The complexities of the varied themes connected to nineteenth-century higher education reforms ensured that its historiography is diverse. While the history of universities is its own subfield, the historiography of the thesis is also situated within the sub-disciplines of the history of science and the history of education. Both science and education are areas of history that encompasses a wide variety of fields. Increasingly, the sub-discipline of the history of science widened to encompass economic, political, scientific, and technical development as well as educational and industrial research.[29] These issues are explored within the overall context of the thesis. Yet, the nineteenth-century debate on the fundamental issue of curriculum reform investigates contemporary works to highlight the varied aspects of the debate. Amongst the nineteenth century writers that focused on the curriculum debate and scientific education and research were philosophers and educationalists such as John Stuart Mill (1806-1873), Herbert Spencer (1802-1903) and Lyon Playfair (1818-1898).[30] Further recent scholarly work that addresses the underlying narratives connected to the development of scientific education and whose arguments support themes investigated in the thesis include the economic research by Sidney Pollard's work 'Entrepreneurship, 1870-1914'.[31] Likewise, the 2000 journal article, 'Science, Technology and Industry in the 19th Century' by Ulrich Wengenroth, whose research covers nineteenth century scientific and technical developments.[32] The marriage of academic science with national economic and commercial concerns is a development which is significant to the thesis, and the investigation by David Landes into technical change and industrial development in Western Europe addresses these connections.[33]

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[29] Stephen N. Broadberry, *The British Economy between the Wars A Macroeconomic Survey* (Oxford: Basil Blackwell Ltd., 1986). Tomás Irish, *The University at War, 1914-25* (Basingstoke: Palgrave Macmillan, 2015). Stephen Cotgrove and Steven Box, *Science, Industry and Society* (London: George Allen & Unwin Ltd., 1970). Michael Argles, *South Kensington to Robbins An Account of English Technical and Scientific Education since 1851* (London: Longmans, Green and Co Ltd., 1964).

[30]John Stuart Mill, *Inaugural Address delivered to the University of St. Andrews Feb 1 1867* (London: Longmans, Green, Reader, and Dyer, 1967), Herbert Spencer, *Essays on Education and Kindred Subjects* (London: Everyman's Library, 1911), http://oll.libraryfund.org/titles/2249 [accessed 8 April 2017], Lyon Playfair, *Subjects of Social Welfare* (London: Cussell & Company Ltd., 1889) https://archive.org/details/subjectsofsocial100play [accessed 2 April 2017].

[31] Sidney Pollard, 'Entrepreneurship, 1870-1914' in *The Economic History of Britain since 1700, 1860-1939* vol 2, ed by Floyd and Donald McCloskey (Cambridge: Cambridge University Press, 1994), 62-89 (pp. 62-89).

[32] Ulrich Wengenroth, 'Science, Technology, and Industry in the 19th Century' in *Munich Centre for the History of Science and Technology* (2000), p. 1-28.

[33] David S. Landes, *The Unbound Prometheus, Technical Change and Industrial Development in Western Europe from 1750 to the Present* (London: Cambridge University Press, 1969).

The first part of the study also places higher educational connections within a global perspective, and the 2013 published work by Tamson Pietsch is one particular study on colonialism that addresses the role of transnational academic networks.[34] Her research into academic connections and networks in a sphere of influence that was dominated and driven by the requirements of colonialism is constructive to the study's exploration of international communities and twentieth century epistemic communities. The research of both Pietsch and Tomás Irish highlight how World War I disrupted academic communities of the combatant countries through the enlistment of students and university staff and the interruption of teaching and research.[35] Furthermore, Irish discusses the ways in which the application of science was important to the conflict. Chapter two of the thesis discusses the disruption of World War I on the University of Wales and argues that the weaknesses in technical and scientific higher education highlighted by the conflict affirmed the decision to establish a fourth university college in Wales. Thereby, the analyses of Pietsch and Irish consolidate this argument. A further study published in 1963 is beneficial to assessing the development of academic communities, and that is the work by Eric Ashby on the development of the Association of Universities of the British Commonwealth.[36] For the purpose of this thesis Ashby's study is limited, but it does focus on the cultivation of informal and formal academic networks on the national and international stage. A theme that is an integral part of the narrative of the thesis. Furthermore, amongst its informative appendices is a biographical summary of significant early members including the University College of Swansea's first principal, Sir Thomas Franklin Sibly.[37]

Edited collections of essays that consolidate selected themes of a specified area of history are particularly pertinent to the research as they can address numerous research questions. One edited publication that had significance to certain thematic elements of the thesis is the interdisciplinary four-volume work, *A History of the University in Europe* edited by Walter Rüegg, which addresses university developments and the place

[34] Tamson Pietsch, *Empire of Scholars Universities, Networks and the British Academic World 1850-1939* (Manchester and New York: Manchester University Press, 2013). For further reading on globalization and the role of networks within the British Empire see: G. B. Magee and A. S. Thompson, *Empire and Globalisation: Networks pf People, Goods and Capital in the British World, 1850-1914* (Cambridge: Cambridge University Press, 2010).
[35] Irish, *The University at War*. Tomás Irish, 'Fractured Families: Educated Elites in Britain and France and the Challenge of the Great War' *The Historical Journal*, 57 (2014), 509-530.
[36] Eric Ashby, *Community of Universities* (Cambridge: Cambridge University Press, 1963).
[37] Ashby, p. 115.

of scientific teaching and research within the university institution [38] This book series which was published between the years 1992 to 2011 has contributions from international experts on a comprehensive range of themes which focused on the history of the university institution. However, it was the research of contributors in volume three of the series that added to the work in five of the thesis' chapters. Issues of transnational university institutional development and scientific curriculum expansion that are addressed within the thesis were respectively explored in the chapters by Christophe Charle and Anna Guagnina, as were university finance and social expectations after the two world wars in Notker Hammerstein's work.[39] Within the same volume, chapters by Paul Gerbod and Matti Klinge appraise resources and management within the academic space and academic careers.[40] Furthermore, the last volume of Rüegg's series included the contributions of John Ziman and Herbert C. Macgregor whose research were identified in chapter six of the thesis as supporting an argument of Michael Shattock.[41] All three historians explored areas of scientific departmental expansion and supported the argument that academic departmental expansion in Britain followed a traditional path.[42] The above published works are amongst the ever-increasing historiography of the history of science which matches the parallel expansion of post-World War II scientific research and the complexity of scientific collaborations and communities.

Two comprehensive works that navigate the extensive interlinked system of academic/industrial/military scientific networks are *Science in the Twentieth Century and Beyond* (2012) by Jon Agar, and John Krige's *American Hegemony and the Postwar Reconstruction of Science in Europe* (2006), of which the latter also addresses political aspects.[43] These works of Agar and Krige are amongst a number of published scholarly studies that are used in the thesis to explore aspects of the wider political and

[38] Walter Rüegg, A History of the University in Europe, volume I-IV (1992-2011).
[39] Christoph Charle, 'patterns', Anna Guagnini, 'Technology', Notker Hammerstein, 'Epilogue: Universities and War in the Twentieth Century' in *A History of the University in Europe volume III* ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004).
[40] Paul Gerbod, 'Resources and Management', Matti Klinge, 'Teachers' in *A History of the University in Europe vol III,* ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004).
[41] John Ziman, 'The Mathematical, Exact Sciences', Herbert C. Macgregor, 'The Biological Sciences' *in A History of the University in Europe vol. IV* ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2011).
[42] Michael Shattock, 'The Creation of a University System' in *The Creation of a University System* ed. by Michael Shattock (Oxford: Blackwell Publishers, 1996), 1-31.
[43] Jon Agar, *Science in the Twentieth Century and Beyond* (Cambridge: Polity Press, 2012). John Krige, *American Hegemony and the Post-war Reconstruction of Europe* (London: The MIT Press, 2006).

international themes that the main discussion of the thesis interlinks with. Of relevance to the thesis include ‘Pure Science with a Practical Aim: The Meanings of Fundamental Research in Britain, circa 1916-1950’ by Sabine Clarke.[44] An addition to the historiography of science are the published research papers on the innumerable areas of progression in academic science and technology. Also, contemporary specialised journals generated by science disciplines for the wider scientific community become part of the argument. While designated as a primary source such journal articles are a key element of the historiography of the development of academic science disciplines. Included in this research are articles in scientific journals which focus on the wider issues of funding such as ‘Grants for Industrial Scientists’, as well as articles that focus on departmental building projects at the Swansea institution. For example, Professor H.E. Street’s article in the leading multidisciplinary science journal, *Nature* on the construction of the natural science building at the Singleton campus.[45]

As well as the previously mentioned historiographies, another area of history that is referred to in the research, albeit placed on the periphery of the study, is welsh cultural and social studies. The limitations of the historiography in this area of Welsh history were discussed by Neil Evans in 1992, who argues that Welsh social history was more often than not placed only in the nationalist context.[46] However, with regard to the themes that are tackled within the content of the thesis, scholarly works that concentrate on Welsh cultural and social studies are used to support issues of regional development and unemployment. Such publications include *Rebirth of a Nation: Wales 1880-1980* by Kenneth Owen Morgan, and the edited works, *Wales. A New Study* edited by David Thomas and Brinley Thomas’ *The Welsh Economy Studies in Expansion*.[47] A more recent overview of Welsh history is the published research by Martin Johnes, which addresses a broad range of issues that have affected Welsh society since 1939. For the purpose of this thesis, Johnes’ engagement with the theme of the changing

[44] Sabine Clarke, ‘Pure Science with a Practical Aim: The Meanings of Fundamental Research in Britain, circa 1916-1950’, *Isis,* vol. 101 (2010), 285-311.
[45] News and Views, ‘Grants for Industrial Scientists’, *Nature,* 210 (1996), 356. H. E. Street, ‘University College of Swansea New Science Laboratories’, in *Nature* 179 (1957), 124-6.
[46] Evans.
[47] Kenneth Owen Morgan, *Rebirth of a Nation: 1880-1980* (Oxford: Oxford University Press, 1981). David Thomas, ed., *Wales. A New Study* (London: David & Charles, 1977). Brinley Thomas, *The Welsh Economy Studies in Expansion* (Cardiff: University of Wales Press, 1962).

demographics of Welsh society during the 1960s informs the discussion on the student structure at the Welsh university colleges.[48]

Sources and Methodology

Alongside a robust historiographical grounding, this thesis is also based on original empirical research uncovering for the first time a wide range of primary sources. By accessing this previously uncatalogued material the research can challenge assumptions that have been made by previous Welsh institutional histories that have taken a more traditional approach. This is especially relevant to investigating the creation and consolidation of the academic communities of the science faculty and the professional involvement of key members of teaching and technical staff. The primary source material is a collection of university related material that is housed in the Richard Burton Archives, Swansea University. Access to the material has been possible as during the last three years the archivists have catalogued a substantial amount of this material and created a Swansea University archive collection. The collection continues to grow as archivists continue to procure and catalogue further material. Due to the process of cataloguing a certain amount of the primary source material used in the thesis is referenced as uncatalogued, however, these papers have been allocated a box number and a temporary reference code. Due to the complexity of the present situation of the catalogue, these archival items are individually catalogued in the bibliography of the thesis, thereby, with these details future researchers will be able to identify and source particular items. In addition, the items from other archives listed in the bibliography is catalogued in a similar way for stylistic reasons.

The university archive collection is eclectic in the range of its material, with the minutes and reports of the various committees and scientific societies that were established during the institution's early years being pertinent to the study. However, of particular relevance in mapping the establishment of the scientific communities at the institution, as well as the direction of their development is the collection of the correspondence of the registrar, Edwin Drew (1885-1963).[49] In his role as the head of

[48] Martin Johnes, *Wales since 1939* (Manchester: Manchester University Press, 2012).
[49] Richard Burton Archives, Swansea University, Registrar's Correspondence, reference no: UNI / SU / AS / 2 / 1 / 1 – 561.

the institution's administration Drew kept both official and unofficial written communication with university college staff, university officials and outside agencies. This included correspondence from the civic, government, industrial and commercial spheres of influence. In addition, Drew's term of office was long-served, and covered the first 32 years of the institution's history. However, it is unfortunate that the official correspondence of the second registrar, John McIntyre is missing from the university collection. The correspondence of the institution's third principal John Fulton (1902-1986) is available at the archives, but the material only covers a period of seven years.[50] After Fulton's term of office comes to an end there is no available collection of institutional correspondence that can be accessed.

Throughout the chapters the unique collection of primary source material is used to reveal personal views that are expressed, but not necessarily noted in the official calendars and reports of the institution. Therefore, the material offers opportunities to enable the study to follow a more personal approach to an institutional history. However, establishing a framework of the University College of Swansea's pre and early history and its relationship with the Technical College and the local civic authorities has been difficult to verify. This is due to the limited records that have survived of the university college authorities' involvement with the Technical College, and the loss of contemporary records connecting the local authority with the institution. To redress the lack of primary as well as secondary material in educational histories on scientific higher education in Swansea and the region of Wales, research material was obtained from late nineteenth-century and early twentieth-century pamphlets. The pamphlets address and discuss a variety of educational and industrial issues connected to the thesis and are housed in the library of Swansea University.

One notable collection is the Salmon Collection which holds pamphlets specifically relating to higher education issues in Wales such as E. H. Griffiths' pamphlet on the relationship between industry, science and education in South Wales which was published in 1917.[51] Furthermore, the pamphlet collection has a number of issues that relate to the Royal Commission on higher education in Wales, its findings and final report which had a direct bearing on the establishment of the University College of

[50] Richard Burton Archives, Swansea University, Fulton's Correspondence, reference no: UNI / SU / AS / 1 / 1 / 1-93.
[51] Salmon Collection (129), E. H. Griffiths, *Industry, Science and Education (with special reference to the conditions in South Wales and Monmouthshire)* (Cardiff: Roberts & Co.' 1917).

Swansea. The library also houses the institution's annual reports, as well as the inaugural lectures of the appointed professors from the different departments of the science faculty.[52] The latter source came into its own in the later chapters as they throw light on the histories of science disciplines and departments, the highlights of departmental development and research and in some cases departmental future plans. The Inaugural lecture of Professor D.V. Ager is such an example as it details in its account the future plans for a school of Oceanology at the department of Geology.[53] Throughout the thesis the details of the professional lives of individual scientists are explored to determine professional linkages and highlight research communities. One source for this information is the obituaries of deceased scientists which were often written by colleagues and give credence to little known narratives within scientific communities.

In fact, both the inaugural lectures and the obituaries support the methodology taken by the thesis, as they are a useful source in highlighting the research of less senior scientists and often their unacknowledged participation in collaborative research programmes. This omission is especially relevant when concerning female scientists, a situation that concerned the historian Margaret Rossiter. In a paper published in 1993 Rossiter coined a phrase the 'Matilda Effect', which described the phenomenon of male scientists receiving credit for work achieved by female scientists.[54] The source of the obituaries of individual scientists who are investigated in the thesis are varied. Obituaries published in newspapers are mainly in *The Times* and the *Independent*, while those scientists who have achieved the status of being awarded a Fellow of the Royal Society have obituaries in the annually published journal, *Biographical Memoirs of Fellows of the Royal Society*. The place of the newspaper obituary in the national memory and the changing social and cultural backgrounds and gender of individuals depicted in various national newspapers are explored in a journal article by Bridget Fowler and Esperança Bielsa.[55] The statistical analysis in the article reveals that since

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[52] The institution's first three annual reports from 1920-1923 are housed in the West Glamorgan Archives, Civic Centre, Swansea.
[53] Swansea University Library Pamphlets, Box no: JX5133, Inaugural Lectures, 1975-1999, reference no: LF 1217.5.15, Professor D. V., Ager, *Geology as an Environmental Science* (Swansea: Swansea University Press, 1969).
[54] Margaret W. Rossiter, 'The Matthew Matilda Effect', in *Social Studies of Science*, vol. 23 (May 1993), 325-341, The term 'Matilda Effect' is named after the suffragist Matilda Gage whose own scientific research was ignored by historians, and who wrote about women's place in science.
[55] Bridget Fowler and Esperança Bielsa, The lives we choose to remember: a quantitative analysis of newspaper obituaries', *The Sociological Review*, 55:2 (2007), 203-226.

1900 the representation of scientists and academics in national newspaper obituaries has increased but has not overtaken those individuals who predominately are classed as having a privileged background and education. Furthermore, the individuals are predominately male.[56]

This reveals the limitations of the published obituary, especially when researching the background of female scientists, and those scientists born and educated in Wales from working and middle-class backgrounds. An online source that rectifies the limitations of obituaries for this study is the *Dictionary of Welsh Biography.* Similar in context to the *Oxford Dictionary of National Biography*, the *Dictionary of Welsh Biography* is a bilingual website that collates the details of the men and women born in Wales who made a significant contribution to Welsh life, as well as in the wider national and international setting.[57] Thereby, the website is a useful source for obtaining information on scientists, educationalists and industrialists who made a contribution to the establishment and development of the University College of Swansea. Furthermore, it also acknowledges those individuals who are historically unknown or forgotten such as the institution's careers officer Dora Herbert Jones. However, this source does have its limitations, with fewer biographies of women and scientists included in the listings. Consequently, the biography of the female scientist Emily Dix, a significant geologist from Swansea is omitted and accessing the details of her career and research is problematic.

Acquiring information on little known scientists such as Emily Dix required a creative approach. While exploring any historical connections between the University College of Swansea and the National Museum of Wales, a series of little-known letters between the museum's Keeper of Botany, Harold Augustus Hyde, and head of Biology at the science faculty, Professor Mockeridge were identified.[58] This primary source was invaluable in supporting the thesis' assertion that the university college was pro-active in establishing scientific contacts outside of academia. Moreover, the museum also offered information on Emily Dix through the comprehensive research of its head of

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[56] Fowler and Bielsa.
[57] The Centre for Advanced Welsh and Celtic Studies is responsible for the website *Dictionary of Welsh Biography* in partnership with the National Library of Wales. Previous to being catalogued online the original volumes were published by the Honourable Society of Cymmrodorion.
[58] National Museum of Wales, Cardiff, Botany Correspondence Collection, *Letters of Professor Mockeridge*.

Botany, Christopher J. Cleal, who undertook a collaborative study of Dix with Cynthia V. Burek. Their research places Dix squarely in the community of progressive research of the Geology department.[59]

One source that was used in the thesis was oral history. While the use of this source was limited, the perspective and memories of a few individual members of the technical staff did give context to discussions on the ethos of scientific departments at the Swansea institution. While questions are still being considered on whether oral history is a methodology or a theory, the oral history interview is unlike any other historical source. As Lynn Abrams succinctly points out that an oral history is, 'an entry point from the present into the culture of the past'.[60] In her theoretical work Abrams identifies three models of oral history usage: the reminiscence and community model, the second model is evidential, and the third is theoretical. The oral history sources which are used in this thesis are identified as the first model, where the sole purpose was to recover the voices and place them on the historical record.[61] However, the question of the reliability of oral history testimonials is a concern to those historians working to preserve collective memories.[62] With this concern in mind the thesis uses this methodology, and includes information from oral history testimonials of two members of the technical staff included in the project *Voices of Swansea* conducted by Sam Blaxland in 2017.[63] In addition, the oral history collection located at the Science History Institute, Philadelphia, USA, and the *Voices of Science* collection at the British Library, London were accessed for personal testimonies by scientists who had spent time at the University College of Swansea.[64]

As the thesis assesses institutional progression through the development of scientific communities and the creation of networks, the methodological approach to the research takes a more nuanced approach than the Whig interpretation of history. Even though the main disciplines of institutional history and the history of science that frame the thesis

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[59]Cynthia V. Burek and Christopher J. Cleal, 'The Life and Work of Emily Dix (1904-1972)', *Geological Society Special Publications,* 241 (2005), 181-196, doi:10.1144/GSL.SP.2003.207.01.14.
[60] Lynn Abrams, *Oral History Theory* (Oxon and New York: Routledge, 2010), p. 16.
[61] Abrams, p. 15. For further reading on significant developments in oral history, including the impact of digital mobile technologies see the third edition: Robert Perks and Alistair Thomson, *The Oral History Reader,* 3rd edn (London: Routledge, 2015).
[62] Anna Green and Kathleen Troup, *The Houses of History. A Critical Reader in Twentieth-Century History and Theory* (Manchester: Manchester University Press, 1999), pp. 230-31.
[63] Richard Burton Archives, *Voices of Swansea: 1920-2020. An Oral History,* reference no: C0001.
[64] Science History Institute, *Centre for Oral History* https://www.sciencehistory.org/centre-for-oral-history. British Library, *Voices of Science* https://www.bl.uk/voices-of-science.

have historically used a similar approach to their methodology, the Whig approach. The Whig interpretation of history can loosely be classed as a simplified narrative of a linear progression, and histories of science blend well with this methodology.[65] The earlier narratives on science focused on an understanding of the development, evolution and impact of the sciences from antiquity through to the twentieth century.[66] Yet, creative developments in various schools of history, such as the *Annales* ‘school’ which occurred during the Twentieth century placed a new emphasis on social and cultural themes.[67] These interpretations encouraged diversity, as well as encouraging interaction across traditional historiographical boundaries. However, by the very nature of scientific research there is encouragement to look forward and to dismiss the past. This concept discussed in 1966 by J. Burke, Professor of Physical Metallurgy at Swansea remarked that:

> Contemporary university courses of study in science and technology seldom devote much attention to the historical development of the subject. Reasons for attitude are a) pressure on curriculum time by other more important topics. b) the feeling that reference to discarded theories and obsolete experiments is more likely to confuse the inexperienced mind than produce enlightenment…[68]

However, this preoccupation in science has had a negative impact on the historiography of the history of science as details of scientific research and those engaged in them were often discarded. As with histories of science, the early twentieth-century methodology to writing the histories of higher educational institutions took the Whig approach. As many of these institutional narratives were a response to an approaching anniversary, then this methodology would be the expected method of the historian.[69]

As the thesis argues that the delivery of scientific education was crucial to the institution’s foundation and success, it is important to determine the factors that underpinned the success and development of the individual science departments. One of those factors was the professional identity of scientists. In the sociology of science studies undertaken by Stephen Cotgrove and Stephen Box the concept of professional

[65] H. Butterfield, *The Whig Interpretation of History* (London: W. W. Norton & Company Ltd., 1965).
[66] Whig histories of science: William Cecil Dampier, *A Shorter History of Science* (London: Readers Union, 1945. Walter Libby, *An Introduction to the History of Science* (London: Harrap, 1918). Charles Singer, *A Short History of Science to the Nineteenth Century* (Oxford: Clarendon Press, 1941).
[67] Green and Troup, 87-93.
[68] Swansea University Library, Inaugural Lectures, 1959-69, Box no: LF / 1217 .5, Professor J. Burke, *Physical Metallurgy. Past, Present and Future* (1966), p. 3.
[69] Geraint H. Jenkins, *The University of Wales. An Illustrated History* (Cardiff: University of Wales Press, 1993) was commissioned to celebrate the institution’s centenary.

identity and the complexity of professional and collective scientific identities are explored.[70] To connect the professional and institutional experiences that combined to create a framework for community identities within and between the science departments, the thesis relies in part on an 'eco-biographical' approach. The term 'eco-biographical' was conceived by David Cassidy and used in his review of three papers on Einstein's paper on relativity.[71] Cassidy proposed a contextualization of key episodes from a person's personal or professional life or both within their larger background history.[72] In addition, when assessing the circumstances and influences that enabled departmental developments the thesis focuses on the concept of community, this allows for a wider interpretation of institutional development. Furthermore, by exploring the attendant issues of connections and networks, the theme of community can be assessed as a collaborative sphere of influence within and outside of academic, in effect a 'community of interests.'[73]

The question of how to link the local internal departmental narratives to the wider educational, industrial, cultural, political, and military histories that underpin and often interweave with the main event has been problematic. There is a further challenging aspect which is that the themes play out across not only regional and national boundaries but transnationally as well. An editorial by Heather Ellis and Simone Müller gave clarity to this problem. Ellis and Müller prepared this editorial for a cluster of articles which focused on educational networks, and within its conclusion there is mention of the conceptual framework of 'macro' and 'micro' levels of analysis.[74] Using this framework fits neatly into the desired methodology of the thesis, which aims to place local and regional developments (micro level) of the science faculty within the numerous wider national and transnational histories (macro level). This concept is clarified by Bruno Latour who asserts: 'Instead of having to choose between the local and the global view, the notion of network allows us to think of a global entity – a

[70] Stephen Cotgrove and Steven Box, *Science, Industry and Society* (London: George Allen & Unwin Ltd., 1970), pp. 14-35.
[71] David Cassidy, 'Understanding the History of Special Relativity: Bibliographical Essay', *Historical Studies in the Physical and Biological Sciences,* 16. 1 (1986), 177-95 (p. 182)
[72] Cassidy, pp. 182-83.
[73] Richard Burton Archives, Swansea University, reference no: UNI / SU / AS / 1 / 1 / 93, Professor Llewellyn-Jones' term to describe the connection between the Physics and Metallurgy departments at the Swansea institution.
[74] Heather Ellis and Simone M. Müller, 'Editorial – educational networks, educational identities: connecting national and global perspectives' in *Journal of Global History* 11 (2016), 313-319 (p. 319).

highly connected one – which remains nevertheless continuously local’, is a clear analysis of the aim of linking micro and macro histories within the thesis.[75]

The broadening of historical subjects and the advancement of computer technology have encouraged the use of quantitative data.[76] This method of supporting arguments has been used throughout the thesis in the format of tables, graphs and pie charts to quantify specific data relating to themes in the evaluation. However, quantitative data is rarely used within the thesis to assess academic institutional comparisons, the only exceptions being data comparing departmental space and full-time student numbers. While a comparative approach to an academic institution’s history is beneficial in assessing developments at a macro level and in contending with any bias or omissions in institutional archives, this approach would limit the micro level of the study.[77] In fact, while a comparative study would provide breadth to the thesis it would not contribute depth, which was an aim of the project. While secondary literature on academic institutions, such as Hannah Gay’s work on Imperial College and Jack Morrell’s research on the development of science at Oxford University explores similar themes of governance, restructuring and innovation, there is little discussion on the concept of community.[78] A comparative approach to the study of community within different academic institutions would have changed the emphasis of the thesis, whose main focus was on the internal interactions of the science faculty through the concept of community. In practice, a comparative project exploring the themes and archival work undertaken in the thesis would be too extensive for a PhD study.

There is a restriction within the structure of the thesis to the inclusion of the history of certain departments. The thesis does not critically engage with developments in the technical departments such as engineering, although these departments are referred to in relation to inter-departmental collaborations. The same decision is made regarding the inclusion of the progress of the mathematics and philosophy departments. While there

[75] Bruno Latour, ‘On actor-network theory: a few clarifications’, *Soziale Welt*, 47. 4 (1996) 369-381 (p. 37).
[76] Green and Troup, p. 141. For further reading on quantitative data: Roderick Floud, *An Introduction to Quantitative Methods for Historians* (London: Routledge, 2005).
[77] For further reading on comparative historical Analysis see: James Mahoney and Dietrich Rueschemeyer, eds., *Comparative Historical Analysis in the Social Sciences* (Cambridge: Cambridge University Press, 2003).
[78] Hannah Gay, *The History of Imperial College London, 1907-2007* (London: Imperial College Press, 2007). Jack Morrell, *Science at Oxford, 1914-1939: Transforming an Arts University* (Oxford: Clarendon Press, 1997).

are relevant arguments to the inclusion of these departments in a study of academic scientific developments, the decision to exclude them in this research is to ensure a continuity of the narrative and to restrict peripheral complexities. This is essential as the development of the above-mentioned disciplines and the expansion of their sub-disciplines are interconnected to narratives which transcend regional, national, and transnational boundaries, and which in themselves require identification and a measure of investigation.

Educational Reform in Britain

Before addressing the structure of the thesis and a synopsis of the chapters, it is important to position the issue of curriculum reform within the wider educational developments and reforms of the nineteenth century. Primary and secondary educational reform and developments are not explored within the thesis, but they are central to appreciating the scope of the challenges that educationalists faced to create and deliver an education system that offered university education at its apex. The background to educational reform is relevant context to the discussion in the thesis that connects contemporary education provision to its nineteenth century roots.[79] In the wider context of educational reform in nineteenth century Britain, the debate on higher education curriculum issues was just one part of the struggle to expand and upgrade educational provision. In his research on British universities Robert Berdahl refers to ‘a century of reform’ which addresses, albeit not as detailed as in subsequent texts, the complexity and consequences of reforming all levels of education.[80] The provision of schools throughout the nineteenth century was sparse and unevenly distributed throughout England and Wales, with a diverse range of providers ranging from the religious, Church of England, Roman Catholic, Quakers and dissenting groups, charity schools

[79] Michael Sanderson, ed., *The Universities in the Nineteenth Century*. W. E. Marsden, *Unequal Educational Provision in England and Wales: The Nineteenth-Century Roots* (London: The Woburn Press, 1987).
[80] Robert O. Berdahl, *British Universities and the State* (London: Cambridge University Press, 1959), pp. 20-47. For further reading on nineteenth century education reform: Brian Simon, *Does Education Matter* (London: Lawrence & Wishart Ltd., 1985). Sheila Fletcher, *Feminists and Bureaucrats: A Study in the Development of Girl’s Education in the Nineteenth Century* (Cambridge: Cambridge University Press, 1980). Harold Silver, *Education as History: Interpreting Nineteenth and Twentieth Century Education* (London: Routledge, 2013).

and the British and Foreign, and National Societies.[81] Founded in the early part of the nineteenth century the British and Foreign Society (1808) and the National Society (1811) focused on the provision of schools for the poor.[82]

As with other educational providers the National Society had a religious bias to its teaching with the principals of the Church of England being at its centre, while the British and Foreign Society schools were non-sectarian. However, disagreement between the Nonconformists over the desirability of state funding which was initiated in 1833 ensured the decline of the British Society schools and the growth of the National Society institutions.[83] State funding for education was a contentious issue in the nineteenth-century although for reasons that differed from twentieth-century concerns. It was not a case of the size of the state aid, but whether state funding should be given at all. This was an era of individualism and private enterprise, and the concept of a system of educational state funding and compulsory schooling were seen as infringements on personal liberty.[84] Yet, funding was not the only cause for the regional disparities of educational provision, there were also the social, cultural and political factors which were connected to the changing and growing urban landscapes of the late nineteenth century.[85] The speed of urbanisation in Britain and its attendant population growth created further difficulties for educational providers.[86]

Yet, it was educational developments in Wales that are of significance to the educational and cultural discussions within the thesis. In Wales, the 1847 published report of a government inquiry on the state of Welsh education made an impression on the national psyche of Wales.[87] The drive to initiate such an inquiry was fostered by the educationalist Hugh Owen, whose concerns over the state of Welsh education led to his *Letter to the Welsh People* being published in 1843.[88] Written in Welsh Owen's letter was circulated throughout Wales and urged for a system of denominational schools

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[81]W. E. Marsden, *Unequal Educational Provision in England and Wales: The Nineteenth-Century Roots* (London: The Woburn Press, 1987), pp. 25- 33.
[82] J. Gwynn Williams, *The University Movement in Wales* (Cardiff: University of Wales Press), p. 11.
[83] Williams, p. 11.
[84] Eric Midwinter, *Nineteenth Century Education* (London: Longmans Group Ltd., 1970), p. 31.
[85] Marsden, pp. 60-1.
[86] Marsden, p. 60.
[87] J. Stuart Maclure, *Educational Documents, England And Wales 1816 to the Present Day* (London: Methuen & Co Ltd., 1965), pp. 56-7.
[88] Gwyn A. Williams, 'Hugh Owen (1804-1881)' in *Pioneers of Welsh Education Four Lectures* (Swansea: The Faculty of Education, University College, Swansea, n.d.), pp. 67-8.

managed by district committees and supported by government grants.[89] There was a general agreement to Owen's propositions, but concrete action varied from the north to the south of the country due to sectarian religious problems. The rate of progress was steady in North Wales, and by 1846 approximately 40 British schools were established across the region.[90] While the findings of the inquiry highlighted the inadequacies of elementary education across Wales, it also commented at length on the morality of the Welsh people in offensive terms.[91] The report, 'set Wales aflame from Cardiff to Holyhead', resulted in government plans for Anglican schools in Wales to be halted.[92] Out of this resentment a sense of national pride pushed advancements in establishing elementary, and to a lesser extent secondary education.[93]

The debates on the provision of elementary, intermediate, and higher education were often unconnected, and discussions to build a framework of national education were few and often opposed by educationalists with a narrow agenda. The Taunton Report (1869) and the Aberdare Report of 1881 incorporated the necessity of reforming secondary education with the provision of higher education.[94] Within Wales the financial support of secondary education was derived from an amalgamation of sources: county rates, custom and excise duties surplus, state grants and endowments.[95] Unlike previous government inquiries into Welsh education, the *Aberdare Report* stressed the distinct national character of Wales and the relevance of the Welsh language to the nation's education. Consequently, the report stressed the importance of including the instruction of the Welsh language on the curriculum.[96] Furthermore, the report also considered that a Welsh university would be of great benefit to Welsh higher education and suggested so in the third and final recommendation of the document.[97]

The more concentrated issue of university reform was complicated and the struggle for reform was a prolonged business.[98] The need for change grew from an early

[89] W. E. Davies, *Sir Hugh Owen, His Life and Life-Work* (London: National Eisteddfod Association, 1885), pp. 76-9. Included in the text is a translation of Owen's complete letter.
[90] Davies, p. 80.
[91] Maclure, pp. 56-7.
[92] Davies, pp. 87-88.
[93] James Laughlin and Louis R. Klemm, *Progress of Education in the Nineteenth Century* (London: The Linscott Publishing Company, 1907), p. 64.
[94] Leslie Wynne Evans, *Studies in Welsh Education, Welsh Educational Structure and Administration 1880-1925* (Cardiff: University of Wales Press, 1974), p. 27.
[95] Hughes and Klemm, p. 68.
[96] Maclure, p. 113-4.
[97] Maclure, p. 120.
[98] Michael Sanderson, ed., *The Universities in the Nineteenth Century*.

dissatisfaction with England's two universities, the Universities of Oxford and Cambridge, and the disparity of wealth between their colleges and the dominance of Anglicanism within the institutions.[99] As the nineteenth century advanced these specific matters widened to encompass a range of concerns regarding higher education, notably the provision and access to higher education in England and Wales. Furthermore, the demands of an increasing industrialised society and the requirements of professionalism highlighted the limitations of the traditional curriculum, especially in relation to scientific and technical education. Thereby, despite opposition from certain political and educational circles, the reforms had radically remodelled the provision of higher education in Britain by the end of the nineteenth century.[100] The response of authorities, educationalists, and industrialists of the expanding urban areas was the creation of their own higher education institutions, known as the civic university colleges.[101]

In Wales, as in England discussions connected to the needs of industry were considered by the university movement, in addition they were accompanied by a rising Welsh national consciousness.[102] To that end the University College of Wales was established in 1872 at Aberystwyth with the intention that the institution would meet the higher education needs across Wales. However, certain recommendations of the Aberdare Report of 1881 changed the intention of establishing a unitary university, as it asserted that there should be two new university colleges in Wales, one serving the north and one in the south.[103] Three arbitrators, Lord Carlingford, Lord Bramwell and Mr Mundella, were appointed to determine the site of the two new institutions, and consequently a university college was established at Cardiff in 1883 and the following year the University College of Bangor was founded.[104] While the colleges operated independently with their own charters and endowments, there were educational ambitions and a determination to establish a Welsh federal university.[105] This ambition was made clear by the inaugural lecture given by the first principal, Viriamu Jones of

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[99] Pietsch,
[100] Sanderson, ed., *The Universities in the Nineteenth Century*, pp. 142-43.
[101] Sanderson, ed., *The Universities in the Nineteenth Century*, pp. 142-43.
[102] Williams, *The University of Wales 1839-1939*, pp. 2-3.
[103] Williams, *The University of Wales 1839-1939*, pp. 3-4. For further reading on the establishment and development of the three university colleges see: Edward Lewis Ellis, *The University College of Wales, Aberystwyth, 1872-1972* (Cardiff: University of Wales Press, 1972). David Roberts, *Bangor University 1884-2009* (Cardiff: University of Wales Press, 2009). Gwyn Jones and Michael Quinn, eds., *Fountains of Praise: University College, Cardiff, 1883-1983* (Cardiff: University College Cardiff Press, 1983).
[104] Davies and Jones, p. 140, 158 and 161.
[105] Thomas, *Development and Discord in the Welsh Federal University Movement*, p. 7.

the University College of Cardiff who declared, 'that the colleges of Wales will be isolated units until the University of Wales exists, not in name, but in fact.'[106] Nearly a decade after Jones' comment on 30 November 1893, and after complicated discussions between the colleges, civic and government authorities, the University of Wales received its Royal charter.[107]

Aspects of the Welsh university colleges' early developments in scientific teaching and research that relate to themes in the thesis are assessed in chapter two. As an aid to the reader and to illustrate the historical variation in education and as an aid to the reader, the thesis has educational details in a Dramatis Personae of the majority of the individuals mentioned in the thesis. However, it has been difficult to find information of all those referred to, consequently, certain lesser well-known individuals are omitted.

Structure and Chapters

The present thesis is structured into six chapters which are organised into three main parts. The decision to arrange the thesis into three distinct sections is to define specific areas of higher educational developments that related to scientific teaching and research within British academia. The first part of the thesis clarifies the circumstances that led to the decision to establish the University College of Swansea. Therefore, it is essential to explore the arguments relating to the formal acceptance of scientific teaching and research in the academic space, and the extent of the development and success of scientific higher educational developments in Wales. The creation and development of the academic scientific community during the first two decades of the history of the University College of Swansea is the context of the research in the second part of the thesis. While the third part presents research that encompasses the modernization of scientific academic disciplines and expansion of sub-disciplines during the post-war period from 1945 to 1970.

The decision to close the thesis at 1970 was influenced by the fact that this was the end of a significant decade of modernisation for the University College of Swansea. Extending the study into the 1970s and 1980s would direct the research into a complicated period of regression both financially and academically, as financial

[106] Thomas, Development and Discord in the Welsh Federal University Movement, p. 13.
[107] Davies and Jones, p. 189.

restraints curbed expansion and closed science departments.[108] This was a period represented and ominously titled ‘The Turning of the Tide’ in the last chapter of David Dykes historical narrative of the institution.[109] In addition, the research attests that the institution had achieved a scientific academic profile that offered varied curriculum opportunities to students and was a significant asset to industrial, commercial and civic projects.[110] To support these statements the final part of the thesis critically engages with inter-departmental research projects which also benefited the region. Most notably among these were the Lower Swansea Valley Project. Thereby, the ‘sixties’ is an appropriate decade to end a study that has researched the creation, development, and modernisation of the science faculty at the University College of Swansea.

While the thesis explores science faculty developments from the institution’s creation in 1920 through to 1970, the timeline of the first chapter provides essential context by tracing the reform and development of the nineteenth century higher education curriculum. The justification for the prelude is to clarify that nineteenth-century curriculum reforms were relevant to the later modernisation of scientific teaching and research within the academic space. The assertion that curriculum developments questioned the contemporary idea of the university and underpinned the modernisation and expansion of the university institution is explored in the chapter. This is undertaken by identifying the key players who challenged the educational status quo, as well as exploring the nineteenth century debates and influences on the decision to formally include scientific teaching and research on the university curriculum. Furthermore, it is contended that the decision was a necessity as the modernisation of the university underpinned the future economic health of Britain. A comparison to the British academic relationship with industry is drawn from German educational connections with industry. The chapter analyses how the increasing professionalization of the science disciplines and the extension of international scientific networks were reinforced by the world’s fairs and the increasing transnational aspect of scientific educational reform.

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[108] Dykes, pp. 196- 221. For further reading on government policies on publicly funding science during the 1980s see: David Edgerton and Kirsty Hughes, ‘The Poverty of Science: A Critical Analysis of Scientific and Industrial Policy under Mrs Thatcher’ *Public Administration*, vol 67 (1989), 419-433.
[109] Dykes, pp. 196-221.
[110] David Wilmer Dykes, ‘The University College of Swansea’ in *Swansea and its Region* ed. by W. G. V. Balchin (Swansea: University College of Swansea, 1971), 347-362, (pp. 360-61).

The theme of scientific curriculum developments and their expansion in higher education is continued in chapter two. However, it deals specifically with developments within the three constituent colleges of the University of Wales and argues that a key element in the creation of the Swansea institution argument was the failure of the colleges of Aberystwyth, Bangor and Cardiff to address Welsh industry's needs. An assessment of these shortcomings is relevant to understanding the decision to establish a fourth constituent college of the University of Wales in Swansea. The timeline of the second chapter covers approximately the two decades between 1900 and the establishment of the Swansea institution in 1920, the period which covers the four years of World War I. It is affirmed in the chapter that the conflict bought into focus the national concerns of the inadequacy of scientific higher education and academia's relationship with industry. Also, the argument that the specific efforts to counter these inadequacies encouraged the formation of agencies to support the war effort and expanded scientific networks both nationally and internationally is addressed. Furthermore, chapter two states that the regional importance of the metallurgical industry in Swansea to the war effort generated further concern of the area's inadequate scientific teaching and research. An argument that is supported by the findings of the report of a 1918 Royal Commission, whose remit was to investigate the efficiency of the federal system of the University of Wales. The assertion that local key political and industrial players as well as educationalists formed a regional university movement, a community which played a central role in consolidating the creation of scientific and technical tertiary education locally is explored.

To what extent these political and industrial connections and relationships continued and flourished in the first decade of the university college is addressed in the third chapter and second part of the thesis. This theme is explored especially in the context of alleviating the pressures of finance and departmental space which was so crucial to the institution's early survival. However, the chapter initially identifies those scientists who had the responsibility for establishing the institution's initial science departments and explores their professional links with the wider academic and industrial networks. The question of how successful these heads of department scientific were in creating and sustaining a professional community within the separate science departments is addressed, as is the complicated process of creating a functioning science faculty in the newly established institution. As the fourth constituent college of the University of

Wales, the third chapter maintains that it was essential for the University College of Swansea to integrate into the federal system of the university. The argument that senior staff members of the science faculty were pro-active in establishing relations with the institution's sister colleges is explored. In addition, the type of connections and professional relationships established between senior members of the scientific teaching staff and outside bodies and individuals are highlighted and their importance to the institution are discussed.

Departmental achievements of developing a science faculty which was recognised nationally and internationally were halted from further expansion during the 1930s. Chapter four argues that the outside influence of an adverse financial climate impacted on university finances on a national level, thereby limiting staff salaries and future projects. The chapter also identifies domestic problems connected to salaries and inadequate departmental facilities at the Swansea institution that hindered the natural expansion of academic departments. Such adverse stresses on the academic communities of the science faculty are also explored through the context of the cohesion and strength of their departmental communities. Additionally, it is asserted that the established links between Swansea institution and the local industrial community were an asset in lessening the financial hardships of students, and in supporting those affected by the recession in the wider community of Swansea. As well as extending over the decade of the thirties, the timeline of chapter four incorporates the outbreak and duration of World War II. It also highlights how the suspension of peacetime activities under the Emergency Powers Acts affected the organisation and running of the university. This theme is explored mainly through the consequences and experiences of staff members of the science faculty due to the requirements of the 'invasion' of London science student evacuees and the research teams from the Department of Explosives Research of Woolwich Arsenal. Yet, despite wartime pressures the chapter argues that the scientific community at the Swansea institution successfully continued to provide scientific teaching and research for its students.

The final part of the thesis explores the impact of post-war modernisation of science. The arrival of peace in 1945 brought new challenges and opportunities for national and international academic communities, and these are explored in the context of European reconstruction. Chapter five contends that the complex economic and social problems of the post-war years influenced the political decisions that controlled the direction and funding of scientific research. Furthermore, such developments translated into training increased numbers of trained staff and scientists to work in the emerging defence 'Big Science Projects' such as the British nuclear weapons programme. The chapter not only reviews the involvement of individuals from the scientific community from the Swansea institution with this project, but also assesses how effective the University College of Swansea was in creating space and facilities for increasing numbers of science students. Furthermore, chapter five argues that during the 1950s the diversification of the natural sciences propelled the university college authorities to act on the historical plans of a long serving head of department, Professor Mockeridge. The departure of long-serving senior members of staff during this period is an opportunity to explore the dynamics of departmental communities, and the influence of the head of department on the teaching and research status of their department. The theme of modernisation is continued in chapter six and covers the decade of 1960 - 1970.

Concerns regarding adequate departmental space and facilities for increasing numbers of science students had troubled the institution's authorities since its foundation in 1920 and continued to do so. Thereby, the last chapter attests that the requirements of the science department was at the centre of the biggest infrastructure programme that the University College of Swansea had undertaken. It is also noted that in the institution's early history financial hardship compounded these issues. However, the drive for national modernisation released unprecedented funding for universities and the thesis argues that the University College of Swansea exploited this funding opportunity is expressed in the thesis. This period of individual college expansion paralleled internal disputes within the federal system and led to a crisis at the University of Wales. This institutional crisis is discussed as it is asserted in the chapter that the rate and breadth of college developments was one of the main issues that consolidated this internal crisis. Moreover, the repercussions of this dispute on the sovereignty of the colleges are evaluated in relation to the departmental planning of the science disciplines. However, the chapter argues that the modernisation of the Singleton campus gave momentum to its scientific communities to continue to expand their national and international links and to become part of the growing number of 'epistemic communities'.

Chapter One - Prelude: Nineteenth-Century Curriculum Developments

Introduction

Nineteenth century higher education curriculum reforms in Britain were the historical roots of twentieth century scientific curricula, which the chapter argues, was a development that would define the foundation of the University College of Swansea in 1920. Therefore, the first chapter of the thesis explores the background of the expansion of scientific teaching and research in the academic space as it gives valuable context to the main theme. Moreover, the educational and economical arguments for including and developing science subjects on the university curricula were underpinned by the central debate on the idea of the university.[111] The question of whether there were international influences on the scientific educational debates in Britain is answered by assessing the expansion in German scientific university education and the advancement of science in German industries.[112] Yet, due to the complexities of German higher education reform, the subject is only discussed as a comparator to education developments which were realised in England and Wales. Furthermore, curriculum variations in the Scottish universities during this period are discussed in the chapter in a similar way to German educational developments.

This chapter investigates how the political reaction to the inclusion of science modules at university level was closely aligned to national concerns about the state of British industry in the face of increasingly superior competition from Europe and the United States.[113] In addition, placing the curriculum debate in the framework of national public issues is essential to accessing how the topic connected educationalists, politicians, and industrialists. Thereby, this section critically engages with the arguments of the individuals whose contributions were significant to the curriculum debate. Re-defining which subjects were considered appropriate for the university curriculum was not just a response to the need for educational reform. By the second part of the nineteenth-century industrial and commercial needs and political concerns

[111] D. S. L. Cardwell, *The Organisation of Science in England. A Retrospect* (London: William Heinemann, 1957), pp. 45-7. Sir Walter Moberly, *The Crisis in the University* (London: SCM Press Ltd., 1949), pp. 30-43.
[112] Cardwell, p. 49-50.
[113] Cardwell, p. 119.

for the economy consolidated the desire for curriculum reform and the expansion of the university institution. The variation of the themes connected to the reform demand a diverse historiography. Therefore, the specific research of historians from different fields are referred to in the chapter; the economic studies by Sidney Pollard and David Landes, research into nineteenth-century scientific and technical development by Ulrich Wengenroth, the educational and industrial research by Michael Sanderson.[114] The argument for university-based scientific teaching and research was reinforced by the international competitiveness and competition-based ethos of the nineteenth century world's fairs, and this theme is discussed within the chapter.

By accepting that the teaching and research of science and technical subjects could be achieved in an educational rather than an industrial environment, this section asserts that this critical element of the science curriculum debate was an important step towards the institutionalization of science in Britain. Furthermore, the chapter argues that the transnational aspect of scientific educational reform not only encouraged the process of widening the university curriculum in Britain to include scientific disciplines, but also improved academic standards and cultivated the professionalization of academic scientific research. Additionally, this part maintains that such developments had a direct impact of extending the European scientific academic network into a global community, as the established channels of colonialism exported the liberal idea of a university education in which science became an established part of the curricula. Yet, an increase to the syllabus and the specialisation of science led to problems which renewed the curriculum debate. Finally, the chapter touches on the social consequences of curriculum developments in universities and argues that while the expansion of scientific teaching had a direct impact on the demographic make-up of the student population, this was not the case in Wales. In addition, the success of the constituent colleges of the University of Wales in adhering to its remit of encouraging and supporting poorer students to study at its colleges is assessed in the final part of the chapter.

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[114] Pollard, pp. 62-89). Landes. Ulrich Wengenroth, 'Science, Technology and Industry in the 19th Century' in *Center for the History of Science and Technology* (2000), 1-28. Sanderson, *The Universities and British Industry.*

The Role of the University

The establishment in 1920 of a fourth constituent college of the University of Wales at Swansea was a recognition of the continuing neglect by the colleges of the University of Wales in providing scientific teaching and research that addressed the needs of industry.[115] The issue of providing a comprehensive science curriculum in academic institutions was a protracted challenge, which the University of Wales and the English civic universities started to address during the latter part of the nineteenth-century. The foundation of these new institutions steered higher education away from the path of the traditional institutions of Oxford and Cambridge, with a central development of broadening the curricula to include the sciences with an emphasis on research.[116] This was a direction which was greatly influenced by the German model of higher education.[117] The early debates on higher education in Germany had been influenced by the writings of the German philosopher, Friedrich E. D. Schleiermacher (1768-1834).[118] Schleiermacher's vision of a university proposed that the institution should: 'awaken the idea of scholarship in noble-minded youths already equipped with knowledge of many kinds, to help them to a mastery of it in the particular field of knowledge to which they wish to devote themselves.'[119] Schleiermacher's comments were written at a time when the philosopher Wilhelm von Humboldt (1767-1835) was formulating principles to reform the German institutions, universities and academies.[120] By recognising that the early nineteenth-century system of separating the roles and activities of teaching and research undertaken in exclusive institutions was not conducive to academic progression, Humboldt offered an alternative structure.[121]

Humboldt concluded that there were important connections which existed between the scholarly application of teaching and the production of research, and this

[115] Sanderson, *The Universities and British Industry,* pp. 134-36.
[116] Eric Ashby, *Adapting Universities to a Technological Society* (London: Jossey-Bass Publishers, 1974), pp. 4-5. For further reading on civic universities see: William Whyte, *Redbrick: A Social and Architectural History of Britain's Civic Universities* (Oxford: Oxford University Press, 2015).
[117] Ashby, pp. 4-5.
[118] Christophe Charle, 'Patterns' in *A History of the University in Europe (1800-1945),* vol. III, ed. by Rüegg, Walter (Cambridge: Cambridge University Press, 2004), 33-73 (pp. 48-49).
[119] Charle, pp. 48-49.
[120] Gary Rolfe, *The University in Dissent: Scholarship in the Corporate University* (London and New York: Routledge, 2013), pp. 73-75.
[121] Rolfe, p. 73-75.

connectivity would negate the necessity for research only institutions.[122] This concept of the ideal of scholarship was supported by Schleiermacher who wrote:

> ... to see every individual thing not in isolation, but in its closest scholarly connections, relating it constantly to the unity and entirety of knowledge, so that in all their thought they learn to become aware of the principles of scholarship, and thus themselves acquire the ability to carry out research, to make discoveries, and to present these, gradually working things out in themselves.[123]

This was a challenging concept, and especially so when attempting to apply these ideals to actual university life. However, by connecting with and engaging with such liberal ideas, the institution of the university was able to absorb the various intellectual and social developments of the nineteenth century. Schleiermacher and Humboldt's vision of a university underpinned the philosophy of the Berlin University model.[124] Both men assembled the statutes for Berlin University and established a commission of four individuals to draft the provisional statutes, with Schleiermacher having the added roles as secretary and chief draftsman.[125]

The effort to implement the ideal of linking teaching and research within the German system was partially curtailed at the onset, as research initially played a lesser role than teaching and only gradually became part of seminars.[126] These developments in German higher education resulted in greater numbers of matriculated students than existed in mid nineteenth century Britain.[127] This is not surprising as by 1850 the number of universities established in Britain had increased very little, with only the University of London (1836) and St. David's College Lampeter (1822) being added to the list of the traditional universities of Oxford, Cambridge and the four Scottish universities.[128] In Wales, the college at Lampeter was founded to provide specialized theological education for Nonconformist students as access to higher education at

[122] Rolfe, p. 73-75
[123] Schleiermacher cited in Charle, pp. 48-49.
[124] Charle, pp. 48-49.
[125] Richard Crouter, *Freidrich Schleiermacher: Between Enlightenment and Romanticism* (Cambridge: Cambridge University Press, 2005), p. 147.
[126] Charle, pp. 48-49.
[127] Charle, pp. 48-49. For further reading on the influence of German Higher education during the nineteenth century see: John R. Davies, 'Higher Education Reform and the German Model. A Victorian Discourse' in *Anglo-German Scholarly Networks in the Long Nineteenth Century* ed. by Heather Ellis and Ulrike Kirchberger (Leiden: Brill, 2014).
[128] Pietsch, pp. 202-03. The University of London encompassed the colleges

Oxford and Cambridge required students to pass the religious tests.[129] Therefore, the college's strict theological educational remit ensured that the institution was not involved in the debate on scientific educational reform.[130] Furthermore, its restricted curricula would present problems for the college in 1891 when the draft charter of the University of Wales was being drawn up.[131]

Bereft of colleges or a university the only scientific teaching or research undertaken in Wales during the first part of the nineteenth century was at the Royal Institute of South Wales (RISW).[132] The annual reports of the RISW reveal a graduation from public scientific lectures and demonstrations to a defined 'school of science'.[133] The scientific disciplines taught formally at the RISW building filled this neglected area of scientific education in South Wales, with students being given the opportunity to sit exams for the Science and Art Department at Kensington.[134] However, during the second half of the nineteenth century higher education and its associated curriculum became a pressing issue. Educational issues were promoted in a public space in Wales through its unique annual cultural festival the Eisteddfod. At the Swansea Eisteddfod of 1863 the call to establish a Welsh university was extended through the association's regular meetings with the Honourable Society of Cymmrodorion, where educational topics increasingly became the subject of choice to debate.[135] Consequently, in the autumn of that year the ambitions of the educationalist Sir Hugh Owen (1804-1881) to establish a Welsh university were reignited at a meeting with other prominent Welshmen on 1 December 1863 at the Freemason's Temple, London.[136] Those who attended this meeting had been sent copies of an address by Dr Thomas Nicholas (1816-

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[129] T. I. Ellis, *The Development of Higher Education in Wales* (Wrexham: Hughes & Son, 1935), p. 17.
[130] Thomas, p. 18.
[131] Thomas, p. 18. Further reading on Lampeter's relationship with the University of Wales: J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997), pp. 204-7. National Library of Wales Archives, Aberystwyth, University of Wales Archives, reference no: F / 21, *Report of the Conference held at Shrewsbury* (11 November 1891), pp. 5-6.
[132] Ronald Rees, *Heroic Science Swansea and the Royal Institution of South Wales 1835-1865* (St. Athan: Glyndŵr Publishing, 2005), p. 78.
[133] Swansea Museum Library, *Royal Institution of South Wales, Annual Reports.*
[134] Swansea Museum Library, *Royal Institution of South Wales, Annual Reports.* Further reading on the RISW's involvement in education: Hugh M. Davies, *The Place of the Royal Institution of South Wales in the History of Scientific and General Education in the Nineteenth Century* (University College of Swansea, 1940).
[135] Cadwaladwr and Jones, pp. 71-72.
[136] Davies and Jones, pp. 72-73.

1879) a Nonconformist minister prepared, which was comprehensive in its account of why Wales should be provided with higher education.[137]

Unlike the earlier educational reform debates by Owen and his colleagues, Nicholas's argument was unique in that it connected the necessity of providing scientific and technical education on the curricula of future higher education institutions in Wales.[138] Nicholas's address stated that the lack of higher education in Wales at a time of unprecedented growth in the commercial, industrial and shipping sectors was a serious disadvantage to the Welsh economy.[139] Furthermore, the lack of skilled Welsh scientists and technicians meant that specialized jobs had to be given to individuals from outside the Principality. As Nicholas stated; 'The direction of our large and lucrative undertakings, the chief posts in the country which require superior skill and attainments, are monopolized by strangers'.[140] With these circumstances in mind, Nicholas wrote that it was imperative that any future University of Wales should satisfy the demand for scientific and technical education in the curriculum. Significantly, a year later in 1864 the expressions of the urgency of delivering scientific and technical education had diminished in the document that declared the aims and proposals of the newly formed Executive Committee. The new emphasis was on securing 'superior classical, mathematical and historical attainments', and only promising to 'secure respectable acquaintance' with the sciences and technology. The ambiguity of the later document could be connected to the political as well as the educational pressures placed on the Welsh University movement to provide a curriculum, which would 'give to the culture of the *individual*, but also, and very especially, in the general *diffusion* it would secure to this culture'.[141] However, the publication in 1881 of *The Aberdare Report* confirmed the importance attached to science, noting that 'science should occupy a prominent place in the curriculum of the colleges.'[142]

The question as to whether the teaching of science and technical subjects should have a place in academia stimulated intellectuals within institutions across the country. There was criticism of the limitations and specialization of the curricula of the English

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[137] Davies and Jones, pp. 72-73.
[138] Sanderson, *The Universities and British Industry*, p. 122.
[139] Davies and Jones, pp. 73-75.
[140] Nicholas cited in Davies and Jones, pp. 72-74.
[141] Davies and Jones, pp. 72-84.
[142] Maclure, pp.112-19.

universities, Oxford and Cambridge, with particular disapproval originating from within the four Scottish universities of St Andrews, Glasgow, Aberdeen and Edinburgh.[143] The Scottish universities maintained a strong tradition of encouraging a broad syllabus which included science and technology, with the institutes resisting a move towards specialization in the 1830s and 40s.[144] This dismayed those educationalists who wished to reform the Scottish curriculum along Cambridge lines, and sought to introduce the specialized study of mathematics. The introduction of specific modules was seen by Scottish educationalists as a threat to the existing curriculum which favoured connections between experimental science and practical and technical skills.[145]

As early as the late eighteenth century the differences between the English and the Scottish university curriculum were pronounced, a situation verified by an interesting comment under the heading of *University* in the third edition of the *Encyclopaedia Britannica* published in 1797, which states:

> while the English universities, aided by their great schools and which we have nothing that can be compared, are unquestionably fitted to carry their young members farthest in the knowledge of the learned languages, the mode of teaching in our own universities is better adapted to the promotion of arts and sciences, and the communication of that knowledge which is of most importance in active life.[146]

Yet, despite an often-negative attitude to the inclusion of science in university curricula on the part of educationalists, scientific research was being undertaken at the traditional universities during the first part of the nineteenth century.[147] However, those who were involved in practising science in the universities during this period were already learned and established practitioners of science and did not engage in formal teaching. At Oxford William Buckland (1784-1856) and Charles Daubeny (1795-1867) carried out research in geology and botany, while at Cambridge the mathematical research of a network of friends, John Herschel (1792-1871), Charles Babbage (1791-1871), George Peacock (1791-1858), William Whewell (1792-1866), and George Airy (1801-1892)

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[143] J. P. Powell, 'Some Nineteenth-Century Views on the University Curriculum', *History of Education Quarterly*, 5 (1965), pp. 100-1.

[144] Powell, pp. 100-101.

[145] Powell, pp. 100-101.

[146] Colin MacFarquhar and George Gleig, eds., *Encyclopaedia Britannica* 3rd ed. (1797), <https://archive-org/stream/gri33125011196348#page/n689> [accessed 27 May 2017] p. 684.

[147] Michael Sanderson, 'The Old System under Attack, 1809-45' in *The Universities in the Nineteenth Century*, ed. by Michael Sanderson (London and Boston: Routledge & Kegan Paul, 1975), pp. 30-31.

ensured the establishment of French mathematics as a discipline in England.[148] Additionally, the Cambridge 'scientific group' promoted and ensured the success of the British Association for the Advancement of Science (BAAS) founded in 1831.[149]

The foundation of the BAAS was partly in response to a book written by Babbage in which he criticised the Royal Society, the state, and society for the decline of science in England.[150] Such criticisms were disputed by some members of the Royal Society, and according to a letter published in *The Times*, 'caused much conversation in the scientific world as well as in the universities'.[151] Yet, the annual meetings of the BAAS which were held across the country were a fundamental influence on drawing those interested in science together, and which offered an environment where scientific papers were read and scientific information was disseminated to an interested public.[152] These goals were achieved when the BAAS first visited Wales in 1848 and was hosted by the RISW in Swansea. During the visit the scientific community in Swansea was expanded as internationally acclaimed scientists delivered scientific papers at the event which covered a comprehensive range of scientific disciplines.[153] However, the impact of the BAAS on educational change was limited, which was partly due to the attitudes of its founders and prominent members such as Babbage. BAAS members had encouraged a culture of scientific independence and freedom from state interference, which formed part of their remit to raise the public image of scientists away from the reclusive often unmanly portrait of the 'man of science'.[154]

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[148] Sanderson, 'The Old System under Attack', pp. 30-31. Prior to this development mathematics had been studied as an intellectual discipline, and regardless of the fundamental relationship with technology and science was considered to have no practical application. See Michael Argles, *South Kensington to Robbins* (London: Longmans, Green and Co. Ltd., 1964), p. 10.
[149] Sanderson, 'The Old System under Attack', pp. 30-31.
[150] Cardwell, p. 47.
[151] A Correspondent, 'The Royal Society', *The Times*, May 1830, Letter to the Editor, p. 3.
[152] Jack Meadows, *The Victorian Scientist. The Growth of a Profession* (London: The British Library, 2004), p. 86.
[153] J. Murray, 'Report of the Eighteenth Meeting of the British Association for the Advancement of Science: Held at Swansea in August 1848' (1849), *Biodiversity Heritage Library*, http://www.biodiversitylibrary.org/item/46637 [accessed 11 November 2019]pp. iii-viii. For further reading on the BAAS and nineteenth century societies: Louise Miskell, *Meeting Places: Scientific Congresses and Urban Identity in Victorian Britain* (Surrey: Ashgate Publishing Limited, 2013).
[154] Heather Ellis, 'Men of Science: The British Association, Masculinity and the First World' in *The Academic World in the Era of the Great War* ed. by Marie-Eve Chagnon and Tomás Irish (London: Palgrave Macmillan, 2017), p. 43. For further reading on the complex and changing role of the 'men of science' see: *Heather Ellis, Masculinity and Science in Britain, 1831-1981* (Genders and Sexualities in History) (London: Palgrave Macmillan, 2018).

Certain negative views that were held of academic scientists were not unfounded, especially relating to the dubious university teaching conventions of the earlier part of the nineteenth century. A prime example being Babbage's teaching record as the Lucasian Professor of Mathematics at Cambridge, a post which he held for eleven years without giving a single lecture.[155] Babbage was not alone in retreating from lecturing obligations. In 1839, professors of Physics, Chemistry, Geology and Botany at Oxford had petitioned the University for exemption from their lecturing obligations, with the reason they offered being the lack of students.[156] It is therefore not surprising that the standard of university education and its teaching practises became a serious concern of the British public. As with many nineteenth century debates, the question of university reform was disseminated through discussions in circulating pamphlets, as illustrated by the 1868 discourse *Endowment or Free Trade* by Robert Lowe (1811-1892), M.P for the London University, who noted that:

> In the universities very little is learnt from the professors, who have fixed salaries; somewhat more from tutors, who have some interest pecuniary and personal in the success of their colleges: but the main weight of teaching, especially for the highest honours, rests on private tutors or coaches who have no endowment – no university status – [157]

It is not surprising that Lowe was compelled to make the comments that he did. During the middle decades of the nineteenth century the connections between poor teaching, a lack of a comprehensive tertiary science education and the failings of British industry were being made and debated at a national level.[158]

The discussions on the connections between poor quality science education and failing industry diversified the 'science tertiary education' debate, thereby preventing it from becoming a single-issue discussion on the idea of a liberal university.[159] The increasing complexity of the debate attracted input from across the British social strata, and importantly the debate crossed over from the education world into the industrial and political spheres of activity. Consequently, high profile government ministers joined educational reformers in taking a prominent role in the conversations on this

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[155] Garry J. Tee, *Charles Babbage's Contributions to Statistics* (1990), http://iase-web.org/documents/papers/icots3/BOOK2/B1-14.pdf [accessed 2 May 2017] pp. 100-4.
[156] Argles, p. 10.
[157] Salmon Pamphlet Collection (96), Robert Lowe, *Endowment or Free Trade* (London: Robert John Bush, 1868) p. 14.
[158] Sanderson, p. 16.
[159] Sanderson, p. 16.

increasingly long-standing public debate.[160] Indeed, the contribution of two of the more prominent politicians would shape the education of science, Lord Henry Brougham (1778-1868) and Lord Richard Haldane (1856-1928). Both men would achieve the political role of Lord Chancellor and would use their influence to raise the profile of educational reforms.[161] During the first half of the century Brougham would head a campaign which raised the profile of science across society and would also address the lack of provincial universities.[162] In the later part of the century Haldane played a major part in continuing to keep scientific education in the public domain, and played a key part in establishing the educational independence of the civic universities and the creation of the Imperial College of Science and Technology.[163]

Haldane took a special interest in the development of Welsh higher education and was enthusiastic regarding the establishment of the University of Wales and its three constituent colleges at the end of the nineteenth century.[164] This enthusiasm led to Haldane speaking frequently in public on educational developments in Wales, even suggesting in a parliamentary debate in 1899 that 'Scotland had everything to learn from Wales in higher education'. Haldane's education at Göttingen influenced his philosophy on education and its role in society. Indeed, the consolidation of Welsh identity and education through the Welsh university movement mirrored his deep belief in the concept of *Lehrfreiheit.*[165] Therefore, while not a first choice, Haldane's interest in Welsh higher education led to his appointment as chair of the seminal Royal Commission on higher education in Wales in 1916.[166] This commission undertook a full-scale appraisal of university education in Wales, of which one major recommendation by the Commission was to establish a fourth university college in Swansea.[167]

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[160] James Gerald Crowther, *Statesmen of Science* (London: The Cresset Press, 1965), pp. 273 and 288.
[161] Crowther, pp. 273 and 288.
[162] Crowther, p. 273.
[163] Crowther, pp. 273-274.
[164] Eric Ashby and Mary Anderson, *Portrait of Haldane at Work on Education* (Hamden, Conn: Archon Books, 1974), pp. 124-5.
[165] The concept *Lehrfreiheit* translates as academic freedom. For further reading on the concept see: Henry Steele Commager, The University and Freedom: "*Lehrfreiheit* and *Lehrnfreiheit*", *The Journal of Higher Education*, 34. 7 (1963), 361-370.
[166] Ashby and Anderson, pp. 123 -26.
[167] D. Trevor Williams, *The Economic Development of Swansea and of the Swansea District to 1921*(Cardiff: University of Wales Press, 1940), p. 106.

Details of the Royal Commission and the consequences of its report are explored in the following chapter. However, prior to these developments in nineteenth century Wales the university curriculum debate was dominated by the arguments of a few individuals, as is the case in most debates. In a paper discussing the establishment and development of science subjects in British universities, the Irish historian, F. S. L., Lyons suggested that once the debate became a national discussion there were four participants whose statements had influential dominance. An appraisal of the position taken by the four advocates, Matthew Arnold (1822-1888), John Stuart Mill, Lyon Playfair (1818-1898), and Thomas H. Huxley is necessary to place curriculum reform in the wider framework of educational reform. Huxley agreed with both Mill and Arnold that the concept of liberal university education needed to be redefined, as the concept of liberalism was evolving due to the pressures of a changing industrial society.[168] Furthermore, Huxley was a tireless campaigner for the inclusion of the natural sciences in universities, and his work significantly influenced university education.[169] In his essay 'On the Educational value of the Natural History Sciences' (1906), Huxley concludes:

> Leave out the Physiological sciences from your curriculum, and you launch the student into the world, undisciplined in that science whose subject-matter would best develop his powers of observation; ignorant of facts of the deepest importance for his own and others'welfare. . .[170]

The fourth participant was Lyon Playfair an influential politician and a leading advisor on scientific matters and education.[171]

Playfair's scientific education as a student at Giessen and later as a PhD researcher under the supervision of the influential chemist, Justus von Liebig (1803-1873) shaped his ideas.[172] By receiving an education dedicated to pure science Playfair's perspective on university reform was that it was paramount to the success of British business that universities offer professional scientific training.[173] Playfair was passionate in his belief that: 'Universities should understand that if they desire society to uphold their ancient

[168] Francis Stewart Leland Lyons, 'The Idea of a University: Newman to Robbins', in *Universities, Society, and the Future,* ed. by Nicholas Phillipson (Edinburgh: Edinburg University Press, 1983) p. 118.
[169] Powell, p. 107.
[170] Thomas H. Huxley, *Science Huxley's Essays* ed. Ernest Rhys (1906), www.gutenberg.org/files/40257/40257/-h/40257-h.htm [accessed 30 May 2017] p. 281.
[171] Crowther, pp. 105-9.
[172] Argles, p.16.
[173] Lyons, p.118.

rights, they must show themselves willing to extend modern obligations to a contemporary society'.[174] Mill took a far more traditional stance and agreed with John Henry Newman (1801-1890), that the fundamental role of a university was to deliver a traditional liberal education.[175] Newman's *Discourses on University Education* (1852) explained his position:

> Liberal education makes not the Christian, not the Catholic, but the gentleman. It is well to be a gentleman, it is well to have a cultivated intellect, a delicate taste, a candid, equitable, dispassionate mind, a noble and courteous bearing in the conduct of life:- these are the connatural qualities of a large knowledge: they are the objects of a University....[176]

However, Mill's views differed from Newman in that while he proposed that a classical education was the best 'discipline for the enquiring intellect', he accepted that the sciences were desirable for the complete higher education.[177]

Mill's view on what type of institution science subjects were to be taught in was an entirely different matter. The question of whether scientific education was to be conducted at universities was summed up in his uncompromising Inaugural Lecture as Rector of St. Andrews in 1867, stating that:

> There is tolerably general agreement about what a university is not. It is not a place of professional education. Universities are not intended to teach the knowledge required to fit men for some special mode of gaining a livelihood. Their object is not to make skilful lawyers and physicians or engineers, but capable and cultivated human beings.[178]

This stance reinforced the traditional view of a university's role in society, which was not connected or even useful to a student's prospective profession. The Victorian belief that the university was not established to be a centre of research with the purpose of advancing knowledge, nor was it an institution to undertake professional studies.[179] Any notion of commercialism within the university environment was treated with mistrust, and this suspicion was directed at scientific teaching and research 'practical

[174] Lyon Playfair, *Subjects of Social Welfare* (London: Cussell & Company Ltd, 1889), https://archive.org/details/subjectsofsocial100play [accessed 2 April 2017), p. 384.
[175] Sanderson, *The Universities in the Nineteenth Century*, p. 4.
[176]John Henry Newman, 'A Liberal or University Education', 1852', in *The Universities in the Nineteenth Century* ed by Michael Sanderson (London and Boston: Routledge & Kegan Paul, 1975), p. 124.
[177] Sanderson, *The Universities in the Nineteen Century*, p.117.
[178] John Stuart Mill, *Inaugural Address delivered to the University of St. Andrews, 1 Feb, 1867* (London: Longmans, Green, Reader, and Dyer, 1867), p. 5. http://archives.org/details/inauguraladdress00millgoog [accessed 7 April 2017].
[179] Cardwell, pp. 45-46.

applications' which were deemed as having the taint of commercial materialism.[180] The importance attached to ensuring an untainted study environment is illustrated by the behaviour in 1832 of the geologist William Buckland, who after much considered deliberation refused an invitation to lecture to the Royal Institution. Buckland's reason for his refusal was that he was apprehensive of compromising 'the dignity of the University', due to the Royal Institute's support of practical scientific research.[181]

Individuals like the philosopher and early sociologist, Herbert Spencer (1820-1903) expressed the urgent need for educationalists to accept the importance of a curriculum of science over what he saw as the traditional education for culture and leisure.[182] Spencer believed that knowledge could be graded according to its importance to self-preservation, in maintaining life and health. In his 1861 published volume, *Essays on Education and Kindred Subjects,* Spencer theorises at length on how the application of science had shaped and defined modern Western society. Posing the question 'What Knowledge is of most worth', Spencer answered it with one word, science.[183] Participants in the 'science and university' education debate in Spencer's time clearly understood the financial implications to society of failing to deliver a comprehensive university syllabus. While Michael Sanderson acknowledges Spencer as one of the most vocal advocates of the importance of being able to study science in university and in applying that expertise in society, he also notes the concerns of Matthew Arnold.[184]

Arnold not only worked as an Inspector of Schools, he was a prolific writer on contemporary social and cultural issues such as education, as well as being a poet. The writer was aware of the status given to scientific training in other European countries, especially Germany, as well as he availability of that training. In Arnold's 1865-67 report to the Schools Inquiry Commission on German and English universities, he compared the emphasis on the comprehensive study of science in a German university to the 'formal cultivation of the spirit' in the British ancient universities.[185] The German

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[180] M. G. Brock, 'The Oxford of Peel and Gladstone' in *The History of the University of Oxford, vol VIII Nineteenth Century Oxford Part I,* ed. by M. G. Brock and M. C. Cuthoys (Oxford: Clarendon Press, 1997), pp. 25-26.
[181] Brock, pp. 25-26.
[182] Sanderson, *The Universities and British Industry*, pp. 6-7.
[183] Herbert Spencer, *Essays on Education and Kindred Subjects* (London: Everyman's Library, 1911), pp. http://oll.libertyfund.org/titles/2249 [accessed 8 April 2017]
[184] Sanderson, *The Universities and British Industry*, pp. 6-21.
[185] R. H. Super, ed., Schools and Universities on the Continent / Matthew Arnold (Ann Arbor, Michigan: University of Michigan Press, 1964), p. 331.

educational strategy which the historian Dr Heinrich Von Sybel suggested would enable a young German to, 'qualify himself, through the strict service of science, to be of avail in the service of his country'. Arnold's solution to the tertiary educational shortfall in Britain was the establishment of approximately ten provincial universities serving the educational needs of regional commercial and industrial centres. However, while asserting that a common interest between the institutions could form the basis for a national system of university education, Arnold argued that the degree granting boards should remain with Oxford, Cambridge, and London.[186]

Arnold's concept of a national university system was not a new one. In the early part of the nineteenth century Henry Brougham, the British statesman and educational reformer had conceived the idea of a national university system, with universities established in London and the other large cities providing advanced scientific education.[187] Scientific education in the early part of the nineteenth century took place at institutions other than the university, such as the Royal Institution and by, the mid-century the newly established London Colleges.[188] These institutions namely the Royal College of Chemistry established in 1845, and the Government School of Mines and Science Applied to the Arts formed in 1851 offered scientific and technical education to a different kind of student. The numbers of students they attracted remained modest although constant, as illustrated by the 1845-6 and 1869-70 total for the Royal College of 49 and 41 respectively.[189] Regardless of these small student numbers the college lecturers were some of the most distinguished chemists of the time and enjoyed considerable academic success with the publication of research papers in scientific periodicals.[190] However, as stated earlier in this section Wales did not establish specific scientific educational institutions during this period, with formal scientific higher education being offered after 1872 with the successive foundation of three colleges and a federal university in 1890.[191]

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[186] Sybil cited in Super, pp. 322-24.
[187] Crowther, p. 41.
[188] Sanderson, *The Universities and British Industry*, p. 3.
[189] Cardwell, p. 96. The School of Mines became part of the Imperial College of Science and Technology in 1963.
[190] Cardwell, p. 96.
[191] Robert Anderson, *British Universities Past and Present* (London: Hambledon Continuum, 2006), p. 87. Engineering was also underestimated, for further reading see: Austen Albu, 'British Attitude to Engineering Education: a Historical Perspective', *Technical Innovation and British Economic Performance*, ed. by Keith Pavitt (London and Basingstoke: The Macmillan Press, 1980), 67-87.

Industrial and Commercial Concerns

The achievements and the failures of the University of Wales in delivering a comprehensive scientific curriculum are explored in chapter two of the thesis, especially in relation to scientific and technical education that addressed the needs of the industries of South Wales. An overview of the state of science in Britain suggests a general underestimation of the importance of science to industry on the part of British industrialists.[192] The fact that so many gifted chemists wished to work in many aspects of British industry belies this notion, however it does highlight a blind spot of educationalists and industrialists about where exactly future British scientific expertise was going to emerge from. The research undertaken by Ulrich Wengenroth concludes that during this period technological advancement was not necessarily the prime consideration of many new industrialists. Instead there were more immediate concerns with 'the organisation of labour and space, information about markets, and a new entrepreneurial spirit'.[193] Significant contemporary texts reflect factory organisational and production issues as primary concerns. *An Exposition of the Scientific, Moral and Commercial Economy of the Factory System in Great Britain* (1835) by the chemist Andrew Ure, and *On the Economy of Machinery and Manufacturers* (1835) the fundamental work by Charles Babbage, are two texts in particular which concentrate on these issues rather than on technology or science.[194]

Subsequently, these commercial difficulties were further aggravated by economic decline and rising unemployment figures in Britain during the 1870s to the 1890s.[195] This was also a time in which Britain witnessed an unprecedented growth in foreign imports, especially from Germany and America.[196] Research conducted by David Landes on the historical development of European economies concludes that, the British economy during the nineteenth century was defined by a sudden and protracted deflation from 1817 to 1896 with only one period of seven years of inflation.[197] The period of deflation continued during productive and peaceful decades. Landes'

[192] Cardwell, pp. 124-25.
[193] Wengenroth, p. 4.
[194] Wengenroth, p. 5.
[195] Sanderson, p.15.
[196] Sanderson, p. 15.
[197] Landes, pp. 233-34.

evaluation of this unusual state of affairs, was a consequence of numerous industrial innovations with general application yet with radical implications.[198] This is a general observation of the complications and developments of the British economy and a deeper analysis is not required here, yet in assessing whether commercial failings were indicative of failings in scientific education, it is necessary to be aware of other factors affecting the economy. There was an increasing perception amongst the general population of a stagnant economy, and one key event which enforced this view was the failure to establish British hegemony in the dye Industry.[199]

The decline of the British dye industry was a classic example of the failure of British industry and universities to connect with each for the common good, and in this case the result led to German hegemony in that sector. Likewise, the decline was connected to British commercial failings as Landes concludes, German 'technical virtuosity and aggressive enterprise' led to almost a monopoly in the dye industry and made it Germany's greatest industrial achievement to date.[200] Commercial figures reveal an alarming dissimilarity. In 1879 German production of coal-tar dyes amounted to £2,000,000 while Britain only produced £450,000.[201] Yet, regardless of national concerns about international competitiveness, there was an admiration in Britain of the superiority of German tertiary education. This may be partially due to the relationship that many British reformers who advocated scientific education had with Germany, in that they studied in Germany or had visited the country to assess its education system as a role model for Britain.[202]

It became increasingly apparent to contemporary advocates of reform, that any question of solving the complex issues of higher education would only be successful if ingrained ideas relating to the status of scientific training were resolved. This would prove problematic, as there is evidence the entrenched view of the inferiority of science education continued to linger in Oxford and Cambridge. In the case of some of the new colleges, such as Manchester and Liverpool who were less specialised in technical subjects these attitudes would resurface. This was a consequence of an increasing

[198] Landes, p. 234.
[199] Sanderson, p. 15. W. H. Perkin, a Royal College of Chemistry student discovered the first coal tar dye, mauve, in 1856.
[200] Landes, pp. 275-76.
[201] Cardwell, p. 105.
[202] Sanderson, pp. 15-18.

inclusion of the liberal arts due to their presence on the university curriculum being regarded as a necessary requirement. This was a predicament for the new civic colleges. As while the establishment and role of the civic colleges were intricately linked to the business and civic communities which created and financially supported them, ensuring a university status would place an increasing emphasis on the inclusion of traditional subjects.[203]

The introduction of liberal arts subjects often encouraged and supported the older perceptions of science education. An illustration of this paradox occurs in the text of a letter published in *The Times* on October 6, 1877. The letter, *Industrial Universities* was a reply by the Treasurer of Owens College, Alfred Neild, to a previous correspondent who had argued against new colleges having university status. To support his view Neild wrote:

> We do not pretend to be indifferent to science as a means of industrial progress; but this view of the matter has never dominated the direction of studies of the college...The Governors have always aimed at a complete curriculum of liberal studies and have never manifested the slightest inclination to subordinate this to material interests.[204]

It is unsurprising that there was a measure of disagreement about what subjects were deemed to be suitable on a comprehensive university curriculum, as the question of the inclusion of the sciences was not just an educational question. It was also a question to do with respectability and the degree of status assigned to an institution. The ancient universities of Oxford and Cambridge regarded the teaching of science as not suitable to their role in pursuing truth, so to achieve respectability science studies had to make concessions.[205] The study of science and technology would gradually take different paths with the sciences taking the traditional path and following the classical aim of pursuing the 'truth'.[206]

Historically the alliance between science and technology was a complex one, and one which developed and still does at a different rate depending on the country and the industry.[207] Indeed, in the middle of nineteenth-century Britain increasing developments

[203] Sanderson, pp. 4-6. For further reading on the influence of Oxbridge see: Sarah V. Barnes, 'England's Civic Universities and the Triumph of the Oxbridge Ideal', *History of Education Quarterly*, 36. 3 (1996), 271-305.
[204] Alfred Neild, (1877, October), Industrial Universities [Letter to the Editor] *The Times*, p. 4.
[205] James Taylor, *The Scientific Community* (Oxford: Oxford University Press, 1973), pp. 30-31.
[206] Taylor, p. 31.
[207] Landes, p. 323-324.

and knowledge in both scientific and technical fields encouraged closer links between the two areas of research. As Landes explains, 'if technology continued to pose fruitful problems for scientific research, the autonomous flow of scientific discovery fed a widening stream of new techniques.'[208] Yet, while the connections between science and technology were bound together by common elements, the only direct communication between the two was made through the disciplines of applied science and engineering. With the increase in the newer areas of industrial activity, notably organic chemistry and electrical engineering, it was inevitable that there would be an increasing demand for specialised knowledge. In addition, the increasing complexity of invention and production would necessitate divisions of labour, all of which would require their own specific education and training.[209] Hence, nineteenth-century debates on the suitable forms of engineering education would include conversations on the issue of theoretical versus practical knowledge.[210]

The debate was given added stimulus when in 1867 British failings in the areas of industrial and practical science were revealed in the public arena of the World Fair held in Paris, where British entries failed to live up to foreign competition. At the earlier London-based Great Exhibition of 1851 Britain's achievements were impressive, as the country's exhibitors were awarded the palm of excellence in most of the hundred plus categories. A decade and a half later at the 1867 Paris Exhibition Britain won in only ten of the ninety categories.[211] An American observer at the exhibition took note of the decline, stating:

> The principle nations exhibiting were France, England, Prussia and America. At the former exhibitions of 1851, 1855 and 1862 the English were almost without rivals. On the present occasion they made but a small display, and were vastly outnumbered by France and Prussia, while in point of novelty of form and excellence of workmanship America was admitted to be on par with any nation.[212]

While the world's fairs of the nineteenth century were important international events that showcased the modernity and increasing industrialization of countries, they also

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[208] Landes, pp. 323-324.
[209] Landes, p. 325
[210] Wengenroth, 1-2.
[211] Sanderson, *The Universities and British Industry*, p. 9.
[212] Roderick Floud, *The British Machine Tool Industry 1850-1914* (Cambridge: Cambridge University Press, 1976), p. 70.

connected the past with the present and the future.[213] Yet, underlying the themes of industrial and military commercialism, the nineteenth century fairs showcased an image that promoted European- centred imperialism and colonialism.[214]

Exhibitions presenting the colonial ideal with displays of racial stereotypes were arranged by many European countries.[215] These exhibitions producing popular spectacles, and it was this entertainment aspect which attracted exceptionally large crowds on a daily basis.[216] By default this same audience would also view scientific and technical progress in the 'arenas of industrial competition'. Consequently, the number of people who could view a country's innovations was without precedent with each subsequent event outnumbering the last. The first exhibition of the twentieth century, the 1900 Paris Fair, sold 50 million tickets. According to Bernhard Rieger the successive growth in numbers as well as the size and impressiveness of each consecutive exhibition suggest a transforming world, a future offering progress. Yet, while these events offered an opportunity for nations to showcase their scientific and industrial innovations, there was the risk that competitive failure could also damage international reputations. Britain's disappointing results at successive International Exhibitions proceeded to send alarm bells ringing in government circles and were in effect a wakeup call to industrialists and educationalists.[217]

The poor performance by Britain prompted Lyon Playfair, who was one of the Jurors at the Paris Exhibition of 1867, to make a written submission to the Royal Commission of Inquiry into Schools which was chaired by Lord Taunton.[218] Playfair's report deduced that it was the programmes of advanced industrial and technical education of successful competitors such as France, Prussia and Switzerland that gave them the edge over British entries.[219] Furthermore, concern was also expressed by the

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[213] Bernhard Rieger, 'Envisioning the Future: British and German Reactions to the Paris World Fair in 1900', *Meanings of Modernity Britain from the Late-Victorian Era to World War II* ed. by Martin Daunton and Bernhard Rieger (Oxford and New York: Berg, 2001), 145-164, (pp.146-49).
[214] Jay Winter, *Dreams of Peace and Freedom Utopian Moments in the 20th Century* (New Haven and London: Yale University Press, 2006), pp. 32-37.
[215] Winter, pp. 30-32.
[216] Rieger, pp. 147-49. For further reading on the global historical significance of world fairs see: Alexander C.T. Geppert, 'World Fairs' *Leibniz Institute of European History* (2018). For further reading on the place of world exhibitions in modernity and education see: Martin Lawn, ed., *Modelling the Future: Exhibitions and the Materiality of Education* (Oxford: Symposium Books, 2009).
[217] Rieger, pp. 147-49.
[218] Renate Simpson, *How the PhD came to Britain A Century of Struggle for Postgraduate Education* (Guildford: The Society for Research into Higher Education, 1983), pp. 29-30.
[219] Lyons, p. 126. Simpson, p. 29.

Society of the Arts which in January of the same year organised a conference on the subject.[220] A comprehensive list of delegates were invited, including the mayors of large towns, presidents of chambers of commerce, presidents of learned and professional Societies and city companies, university teachers, school and factory inspectors.[221] The conference discussed resolutions proposing educational reforms, as well as the creation of a standing committee to research and lobby further. The debates at this and other conferences and the written reports of Playfair and other jurors of the 1867 exhibition were evidence that helped the Liberal MP Bernhard Samuelson (1865-1895) convince the House of Commons to set up a select committee to investigate scientific and technical education in Britain and abroad.[222]

This investigation was the start of a series of investigations into science, industry and technical education that continued throughout the rest of the century, and which can place their origins from the Paris Exhibition in 1868.[223] The base line of the Samuelson Report of 1868 and later investigations was that there was an urgent need to establish new schools equipped to give preparatory training, as well as the creation of endowed liberal colleges offering a scientific and technical education with an assessment by modular examinations.[224] Furthermore, in 1872 the Royal Commission on Scientific Instruction and the Advancement of Science, known as the Devonshire Commission proceeded to undertake the most detailed investigation to date into the state of scientific instruction in Britain.[225] The authorisation of the Devonshire Commission was mainly due to the efforts of the council of the British Association for the Advancement of Science who worked as an effective pressure group.[226] Over a period of five years the commission interviewed numerous scientific, industrial and educational experts, with the results of this extensive testimony and the commission's recommendations being issued in eight reports.[227] The third, fifth and seventh reports addressed the provision of

[220] Cardwell, pp. 85-86.
[221] Cardwell, pp. 85-86.
[222] Simpson, pp. 29-31.
[223] Sanderson, p. 14.
[224] Cardwell, pp. 86-87.
[225] Powell, p. 106.
[226] Simpson, p. 31.
[227] Simpson, p. 31. Evidence was taken from experts such as Frankland, Roscoe, Brodie, Burdon Sanderson, Warren de la Rue, Carpenter and C. W. Siemans, (Simpson, p. 43).

science education at the older as well as the new civic universities, and highlighted the necessity for state endowment for universities.[228]

Despite how well the proposals of the Devonshire Commission were received by the science community, there was little political will to implement changes in science education.[229] The reasons for the reluctance of the government to financially support science education and research are complex and would require a separate study to elucidate. Yet a glimpse into the State's reasoning is illustrated by the reaction of Robert Lowe, Chancellor of the Exchequer, to a deputation by the Scottish Meteorological Society's request in 1869 for a £300 annual grant to pursue astronomical observations. Lowe's response was not just a refusal: he also lectured the delegation on the virtues of self-help:

> I am in principle opposed to all the grants and it is my intention not to entertain any applications of this nature. We are called upon for economy… I hold it as our duty not to spend public money to do that which people can do for themselves.[230]

Regardless of the government's *laissez faire* attitude the connection of science education with industry was progressing, and by the end of the century initiatives such as Playfair's scholarship scheme had begun to make an impact.[231]

Playfair's involvement in university educational reform was not just an academic exercise, as he set in motion plans to rectify what he believed was a failing in the university system by organising a programme to offer laboratory training for students.[232] Using funds reserved for science scholarships from the Commissioners of the Exhibition of 1851, graduates could obtain scholarships enabling them to work in university laboratories as well as in other institutes of branches of science. The funding programme awarded 262 scholarships between 1891 and 1906, a success rate mirrored in industry, by connecting nearly half of these graduates with manufacturing and industrial science. Nevertheless, in spite of this progress and reforms to university curricula, such was the concern about Britain's steady decline from being the 'workshop of the world', that in 1895 the Education Department and the later Board of Education

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[228] Michael Argles, *South Kensington to Robbins. An Account of English Technical and Scientific Education since 1851* (London: Longmans, Green and Co Ltd., 1964), p. 27.
[229] Cardwell, pp. 97-98
[230] Cardwell, p. 98.
[231] Sanderson, *The Universities and British Industry*, p. 27.
[232] Sanderson, *The Universities and British Industry*, p. 27

supervised an Office of Special Inquiries and Reports. The remit of this office was to investigate aspects of education systems in other countries. Unfortunately for British prestige, the office produced numerous reports whose conclusions were not favourable in their outcome towards educational arrangements in Britain.[233]

The historiography of the nineteenth-century British higher education system, with its general emphasis on educational failings, clearly does not reflect the progress of scientific education and technical training in Britain. In his work on the history of the British economy, Sidney Pollard stated that while the British tertiary provision did not equal the practical approach of the German *Technische Hochschulen* or the American universities, credit must be given to the establishment of chairs in engineering and associated subjects in the older British universities.[234] Playfair was closely associated with this innovation, suggesting that the new science chairs should be for the benefit of science and not merely for the teaching of professions.[235] It is particularly important to note this development in supporting science in universities, as it was an innovation not mirrored in Germany. Pollard also suggests that later criticism of the tertiary education provision did not consider the significance of the foundation of technical teaching at civic universities such as Leeds, Sheffield, and Manchester. Furthermore, critics of the British system failed to register the availability of evening classes, technical schools, and the London Polytechnics, as well as the City and Guilds' complex examination process for technical subjects. These omissions are of relevance to the analysis, as neither this type of British instruction nor the examination process were available in continental Europe during this period.[236]

Yet, there were serious omissions in the varied curricula of British universities which the Royal Commissions of the Duke of Devonshire and Samuelson in the 1870s and 1880s identified, of which the lack of scientific training in the managerial section was the most disturbing.[237] Michael Sanderson's extensive research on British firms and industry during the nineteenth century confirms the lack of scientifically-trained personnel, and notes that these companies employed mostly German or Swiss

[233] Sanderson, pp. 14-15.
[234] Pollard, pp. 76-77.
[235] Crowther, p. 162.
[236] Pollard, pp. 76-77.
[237] Sanderson, pp. 19-24.

specialists.[238] German chemists were employed right across the spectrum of British industry, from the copper industry in South Wales to the English canning industry. Such a large proportion of the first applied professional chemists working in Britain were Swiss and German, that it became almost a foreign monopoly.[239] English chemists and English professors of chemistry had to obtain training abroad, most notably at Giessen or Heidelberg in Germany.[240] There are always exceptions to the rule, and there were some individuals in Britain who were self- taught and attended chemistry lectures provided by organisations such as the University Extension Movement or the Pharmaceutical Society. Some individuals, such as Henry Deacon who became a pioneering chemist in the chemical industry attended Faraday's lectures at the Royal Institution.[241]

While, there was a need for comprehensive scientific courses at a university level, there was also a reluctance by industry to employ science graduates, which affected the career opportunities for highly trained chemists and physicists.[242] This was a situation Sir Edward Franklin (1825-1899) from the Royal College of Chemistry drew the Parliamentary Select Committee's attention to in 1868.[243] He informed the chairman, Bernhard Samuelson that many chemistry graduates took two to three years to find employment in their specialised field. This reaffirmed the view of contemporary thinkers that the disappointing performance of British industry at the 1867 Exhibition was the consequence of shortcomings in the country's scientific and technical education.[244] Furthermore, it was argued that the commercial health of the nation was affected by poor entrepreneurship and a lack of technological innovation.[245] There was concern regarding the reluctance within British industry to accept technological innovation, especially in respect of updating industrial technical methods and equipment. Consequently, significant British inventions were developed abroad, with the Gilchrist-Thomas basic steel-making process, the continuous rolling mill, and engines driven by furnace gas being examples of British entrepreneurial failings.[246]

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[238] Sanderson, pp. 19-24.
[239] Cardwell, p. 124.
[240] Sanderson, p. 19.
[241] Sanderson, p. 19.
[242] Cardwell, p. 117.
[243] Cardwell, pp. 88-90.
[244] Sanderson, pp. 17-18.
[245] Pollard, pp. 68-70.
[246] Pollard, p. 69.

Exporting similarity

Transnational connections and networks were a vital part of twentieth-century academic scientific research, with international scientific communities consolidating and expanding in the nineteenth century.[247] In his work on the development of science in Europe, Jon Agar notes that one of the greatest achievements of the nineteenth century was 'the invention of methods of exporting similarity'.[248] While Agar notes the similar developments of mass manufacture, he also explores the various models of research facilities including the German model of the research universities and the research based industries.[249] These influences from Germany were in effect transnational influences, which would have an impact on the composition of the university structure in Britain as well as the delivery of its science education.[250] In fact German influence on science education in Britain was apparent even in the first part of the nineteenth century.[251]The establishment of the Royal College of Chemistry in 1845 illustrates this influence by being one of the first institutions in Britain to adopt German methods of research, as developed by the German chemist, Liebig. Subsequently, an influential work of von Liebig's, *Organic Chemistry*, was translated into English by Playfair, and as a result the research became available to a wider influential public.[252] The gradual professionalization of scholarship was also an international development, and was underpinned by increasingly stringent examination requirements to access university education.[253] In France and Germany, examination requirements evolved from a brief dissertation to having to produce a second extensive piece of original research, called *thèse d'état* in France and *Habilitationsschrift* in Germany. The significant improvements that occurred in teaching practice and increasing emphasis on primary research and publication raised expectations of academic standards.[254]

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[247] For further reading on the creation and development of turn of the nineteenth century international networks see, Daniel T. Rodgers, *Atlantic Crossings: Social Politics in a Progressive Age* (Cambridge, Massachusetts: Harvard University Press, 1998).
[248] Agar, pp. 6-7.
[249] See also Jürgen Osterhammel work, *The Transformation of the World* (2014) who makes the same argument as Agar.
[250] Agar, p. 7.
[251] Argles, pp. 9-16.
[252] Argles, p. 16.
[253] Konrad H. Jarausch, 'Graduation and Careers' in *A History of the University in Europe 1800-1945,* vol. III ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004), 363-390 (pp. 369-70).
[254] Jarausch, p. 370.

British acceptance of the importation of superior educational developments from Germany was not just an enlightened response to educational progress, it was also a political reaction to an apprehension about Germany's increasing economic power.[255] These concerns led to closer political and economic ties with the settler colonies of the British Empire and their institutions.[256] Also, educational ties developed during the second half of the nineteenth-century as colonial authorities across the Empire established their own universities, although the structure and curricula were firmly based on the British model.[257] The first university established in Australia was in Sydney in 1850, with the first higher education institution established in New Zealand in 1869.[258] As pressures increased on British universities to develop comprehensive science education and research systems, this pressure would in turn be applied to the settler universities.[259] In her research Tamson Pietsch uses the term 'settler university' to identify institutions created by colonial settlers from those institutions established by British officials.

A vital element in the maintenance of educational connections between Britain and her colonies was the global movement of scholars and academics, which was made increasingly easier in the latter part of the nineteenth century due to Victorian innovations in transport and communications. Both transnational communication and the inclusion of subjects such as science and technology on the curriculum played a significant part in affirming the status and expansion of settler universities, locally and globally.[260] Yet, as Tamson Pietsch notes that these developments in settler universities took place 'in the context of a British university sector that was only reluctantly accommodating itself to the demands of the modern world'. However, by the end of the century developing international networks resulted in institutional as well as personal ambition being given a broader space in which to develop. This was a situation highlighted in 1903 by the vice-chancellor of the University of the Cape of Good Hope, Sir John Buchanan who stated:

> We in the Colonies are very desirous that our best young men should be able to pursue their postgraduate studies in [Britain], and to attain to the

[255] Pietsch, pp. 28-31.
[256] Pietsch, pp. 28-31.
[257] Jürgen Osterhammel, *The Transformation of the World, A Global History of the Nineteenth Century* (Princeton and Oxford: Princeton University Press, 2014), pp. 800-01.
[258] Osterhammel, p. 800.
[259] Pietsch, pp. 28-33.
[260] Pietsch, p. 33.

> high excellence in the different branches of science, physics, chemistry, and other cognate branches of learning which they can only now get by going abroad.[261]

As a result of scientific educational reforms, the 'similarity' of educational developments would be exported across Britain's Empire.

These tertiary educational developments were also being played out in Wales as illustrated by the aims of the welsh university movement.[262]An equally important aspect in the development of science education was that both local industrial needs and institutional identities led to variations in the science curriculum. Earlier studies, such as Cardwell's concluded that the growing specialisation of the syllabus was the natural result of the growth of academic systems, rather than external demands.[263] However, the detailed work by Sanderson investigating the social and industrial background of students from a number of universities, clearly disagrees with this conclusion.[264]Sanderson's study reveals a link between the industrial and commercial background of students of particular university intakes and the teaching and research in the subjects they offered.[265]A growing specialisation of science subjects was an inevitable response to an increasingly crowded syllabus, and the establishment of new courses on the curriculum would control excessive cramming.[266]

Consequently the changing curriculum would lead to the civic universities becoming centres of research which provided expertise to practically all areas of industry, from mining, metallurgy, engineering and commercial chemistry.[267] However, there was concern over the increasing specialisation of science subjects on the academic syllabus, created by the development of the teaching and examination system[268] As the university curriculum expanded there was hostility not only to the departmentalisation of the sciences, but also to the separation of the sciences from the humanities. This was a criticism expressed in 1885 by Playfair during his presidency of the BAAS, who noted strongly that 'the divorce of culture and science which the present state of education in

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[261] Pietsch, p. 5 and 39.
[262] Davies and Jones, pp. 70-74
[263] Cardwell, p. 117.
[264] Sanderson, *The Universities and British Industry*, pp. 97-100.
[265] Sanderson, *The Universities and British Industry*, pp. 100-2.
[266] Anna Guagnina, 'Technology' in *A History of the University in Europe* vol III ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004), 593-616 (pp. 623-625).
[267] Sanderson, *The Universities and British Industry*, p. 119.
[268] Cardwell, pp. 117-18.

this country tends to produce, is deeply to be deplored because a cultured intelligence adds greatly to the development of the scientific faculty'.[269]

As the nineteenth century came to a close it was apparent that there had been credible success in establishing science departments in the newly created civic universities in England and the constituent colleges of the University of Wales.[270] These institutions opened up opportunities to young men and women across the social strata, and were the forerunners of the socially and culturally diverse student population that attended the civic universities which developed later in the twentieth century. The two crucial aspects of nineteenth century university reform, the inclusion of science and technical subjects at universities, and the increasing availability of university education, were defined by their social implications to the university community. This is confirmed by the research of Michael Sanderson on the development of civic universities which explores the social background of the student intake during this period.[271] Yet, while a high percentage of students attending universities such as Birmingham and Nottingham in the 1890s had commercial or industrial family backgrounds, these students were predominately from the middle-class and upper-middle class section of their communities. There was very little involvement with the industrial and commercial working-class.[272]

In Wales there was a determination to address this bias as noted in the Prime Minister Lord Roseberry's (1847-1929) inaugural address at the first meeting of the Court of the University of Wales on 6 April 1894, who stated that 'The University will be a place in the main for poor students.'[273] The only evidence to the social background of students of the University of Wales before 1983 is just from two sources, as the collection of statistical figures in the nineteenth-century was sparse and not as a precise undertaking as it is in modern times.[274] The earliest statistical report by Owen Morgan Edwards (1858-1920), Fellow of Lincoln College, Oxford, is tabled below.

269 Cardwell, pp. 117-18.
270 Sanderson, *The Universities and British Industry*, pp. 3 and 98-100.
271 Sanderson, *The Universities and British Industry*, pp. 97-101.
272 Sanderson, *The Universities and British Industry*, pp. 97-101.
273 Ellis, p. 104.
274 Williams, p. 204.

Figure 1. Statistics compiled by O.M. Edwards (1893)

Family Social Origin	Aberystwyth	Cardiff	Bangor
Upper Class	5.2 (1892)	6.5	2.8
Professional (including clergy and ministers)	48.5 (1892)	20.9	25.5
Commercial	30.3 (1892) 34 (1872-92)	31.8	32.5
Farming	10.8 (1892) 15.8 (1872-92	8.9	13.8
Labouring class	5.2 (1892) 15.2 (1872-92)	30.3	25.4

Reference no: J. Gwynn Williams, *The University Movement in Wales* (Cardiff: University of Wales, 1993), p. 204.

However, his designations of ‘commercial’ and ‘farming ‘are generalised, and do not differentiate between the range of social classes within these terms. For example, the social class of farmers who owned large farms and were comfortably off was quite different to that of tenant farmers with small farms. Statistics compiled by S. T. Evans, M.P. for Glamorgan for a report for a parliamentary debate on the university charter on 29 August 1893 were likely based on Edward’s statistics.[275] By this period the student population of the Welsh colleges of Bangor and Aberystwyth who came from working-class and middle-class homes, had access to an increasing number of scholarships and bursaries.[276]

The change in the demographic make-up of the student populations of higher educational institutions was achieved due to an increasing consensus regarding the necessity of developing and financially supporting a comprehensive system of tertiary science education.[277] The consensus to support the change was a consolidation of diverse pressures, which had been motivated by the regional and national debates on tertiary science education, and the place of science education in British society.[278] While the identity of individual university was shaped by its own unique responses to

[275] Williams, p. 204.
[276] Gareth Elwyn Jones and Gordon Wynne Roderick, *A History of Education in Wales* (Cardiff: University of Wales Press, 2003), p. 98.
[277] Maclure, pp. 112- 125. Main government reports which addressed the reform of secondary education were *The Aberdare Report* (1881) concerned with education in Wales and *The Samuelson Report* (1882-4) concerned with education in England.
[278] Sanderson, *The Universities and British Industry*, pp. 98-100.

regional industrial and civic needs, its characteristics were also reflected in the industrial and commercial background of the student intake of the various civic universities.[279] The connections and interrelations which developed between industry and the English civic universities encouraged and supported the reciprocal benefits between them.[280] Yet, while historians are aware of the facts and directions of the relationships between universities and industry, as Harold Silver observes that very little is known of how those involved in industry and commerce regarded the role of universities and how they operated.[281]

Conclusion

To conclude, the growth of scientific advancement and technical innovation during the early part of the nineteenth century was one of the main reasons behind a determination to reform the curricula at the ancient universities of Oxford and Cambridge. By seeking to change the classical bias of the curricula to include science and technology, the reformists challenged the traditional role of the university in British society. British educational reformers were influenced by the Scottish structure of higher education and the reformed German practise of delivering scientific teaching and research. As the conversations on the philosophical aspect of the idea of a university expanded beyond the internal realm of the university, the debate progressed into a political and public discussion on the connections between educational provision and the needs of industry at both a local and national level. Furthermore, the increasing political concerns about the hegemony of German science in both educational and industrial contexts focused the urgency for university reform. Underpinning these early discussions on higher educational was public disquiet over the standard of education and teaching at university level. A consensus was achieved, albeit an uneasy one, that reform of the tertiary curricula was a national priority.

However, the consensus was strained, as the inclusion of science and technology on university curricula with its accompanying research practices posed questions of retaining academic status, as well as concerns about academia becoming tainted by

[279] Sanderson, *The Universities and British Industry*, pp. 119-20.
[280] Sanderson, *The Universities and British Industry*, pp. 119-20.
[281] Harold Silver, 'Higher Education: The Contenders' in *Universities, Society, and the Future* ed. by Nicholas Phillipson, (Edinburgh: Edinburgh University Press, 1983), p. 217.

commercial interests. The perception that there was a need for action was given added impetus due to the unfavourable economic situation of nineteenth-century Britain. Government concerns regarding industrial decline were publicly reinforced by the poor performance of British innovations at the 1867 World Fair at Paris and subsequent exhibitions. This brought the science curriculum debate into sharp focus and consolidated the connection between an inferior scientific education, a failure to commercialize industrial and commercial innovations, and a stagnating economy. The complicated set of interconnecting political and economic factors that surrounded higher education's internal issue of scientific education would ensure that there would be a fundamental shift to what was considered an appropriate liberal education for an industrial society. This shift enabled the development and specialisation of the sciences in academic institutions, such as the civic universities in England, the constituent colleges of the University of Wales, as well as in British colonial universities. Subsequently, these developments encouraged and expanded European scientific networks which in turn shaped the global scientific community.

While the wider theme of international scientific networks was influenced by curriculum reforms, the university curricula debate at a regional level at English civic universities was a recognition of addressing the needs of industry and commerce. However, in Wales this concern was secondary to Welsh cultural needs which would have consequences for the University of Wales which are addressed in the following chapter. The consolidation of industrial, commercial, and academic requirements through the provision of a scientific curricula widened the demographic make-up of the student population of the civic universities. Yet, the curriculum debate was not an influencing factor on who matriculated at the Welsh university and its three colleges, as enrolling and supporting students from working-class and lower middle-class families was a fundamental factor of the ethos of the Welsh institutions. However, the complexity of the political, educational and cultural issues connected to the establishment of a comprehensive scientific curriculum that endorsed scientific and technical research as well as teaching in university education, ensured that the curriculum debate on scientific inclusion was destined to continue through to the twentieth century.

Chapter Two – Connecting Industry and Academia: The Establishment of the University College of Swansea

Introduction

The establishment of the University College of Swansea in 1920 was a consequence of concerns in Britain over the type of scientific and technical higher education which was being provided by British universities. The chapter identifies the regional and national circumstances that were connected to the decision to site another university college in South Wales. While it is recognised by historians of Welsh higher education that the constituent colleges offered a varied scientific curriculum, the chapter maintains that the colleges failed to engage with Welsh industry and their specific scientific needs during their early history.[282] Furthermore, this section argues that the internal curriculum policies of the Welsh institution's federal system affected the individual colleges' resolve to undertake teaching and research which could be applied to Welsh industry. These educational themes were underpinned by cultural and industrial attitudes to tertiary education and are explored in the chapter. In addition, official reports and contemporary pamphlets are used to support educational arguments that are made in the text.

The Royal Commission whose report instigated the establishment of the college was undertaken during the period of World War I. The conflict is discussed in relation to the disruption to university life by the enlistment of staff and students and the inadequacy of the provision of scientific education and research which was needed to support the British war effort. This section states that the growth of government agencies whose purpose was to address war time concerns in relation to scientific higher education and industry, was an important development in academic and industrial relations. This in turn encouraged new networks and established communities which supported the scientific aspect of the war effort and facilitated post-war academic research. Moreover, the chapter supports the argument that the pressures of war not only encouraged co-operation between academia and industry, but gave the British university community

[282] The early high points of the science departments at the colleges are briefly mentioned in J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997), pp. 90-1. A discussion on the failures of the colleges in scientific and technical education is to be found in Michael Sanderson, *The Universities and British Industry 1850-1970* (London: Routledge & Kegan Paul, 1972), pp. 121-45.

the opportunity to expand and strengthen transnational academic connections.[283] The academic and industrial collaborations which evolved during and after the conflict were an integral part of the discussions which led to the origins of the University College of Swansea, as they draw attention to the necessity for the creation of academic and industrial collaborations in Wales.

The national importance of the industrial areas of South Wales and the lack of the appropriate technical and scientific education in Wales led to representations being made to the 1916 Royal Commission into University Education in Wales. This section critically engages with the proofs of evidence that were given to the Royal Commission which supported the creation of a fourth constituent college at Swansea, and are examined in relation to the importance of the connections between local industry and tertiary education. While the foundation of the university college was underpinned by a public discourse on the provision and development of scientific and technical education in the region of South Wales, the chapter asserts that a network had already been established between the educational, industrial and political communities in the region. Furthermore, while these communities were motivated to support the transformation of the Technical College into a university college at Swansea, this did not materialise. The final part of the chapter contends that the theoretical development of the nineteenth century 'idea' of a university with its associated curriculum complexities instigated the creation of a new educational institution at Swansea rather than upgrading an established one.

Welsh Industrial relations with the colleges of the University of Wales pre-1914

The relationship between scientific higher education and industry in Wales which preceded the foundation of the University College of Swansea had consequences that encouraged the desire for a fourth constituent college. Late nineteenth-century higher educational reforms unfolded opportunities for an increasing number of students who wished to study and research scientific disciplines such as chemistry and physics. The establishment of a federal university and three constituent colleges offered similar opportunities to those students wishing to study in Wales.[284] These educational developments coincided with a need in Britain to equip students with the necessary

[283] Pietsch, pp. 126-138.
[284] Anderson, p. 87.

training to work in the numerous sectors of industry, and to conduct research in the increasing number of science disciplines. This became an increasing responsibility for both local authorities and universities.[285]The need to produce a skilled technical workforce had been partly alleviated during the late nineteenth-century by the inclusion of science into the university curriculum and the expansion of science disciplines, which was a development discussed in the previous chapter.[286]

In England one of the most significant scientific education expansions took place at the University of London. The Royal School of Mines, the Royal College of Science and the Central Technical College merged to form the Imperial College of Science and Technology in 1907 and became a constituent college of the University of London.[287] Similar innovations had taken place in the Welsh federal system of university colleges. In one of the numerous nineteenth century reports set up to investigate education in Wales, the Aberdare Report of 1881 recommended that 'Science, therefore, especially in its application to arts and manufactures, should occupy a prominent place in the curriculum of the colleges.'[288] The response from Welsh educationalists was a positive one, with the three colleges of Aberystwyth, Bangor and Cardiff incorporating different science disciplines onto their curricula in the early stages of their development.[289] Departments of zoology, physics and chemistry were created at all three colleges in the nineteenth-century. As well as engaging in teaching science, professors and lecturers were undertaking research projects in the different science disciplines at all three colleges, a development noted in the 1909 report to the Treasury on the Welsh University Colleges.[290]

Yet, regardless of the inclusion of the sciences on the Welsh university curricula and the creation of research work, there is evidence of a lack of engagement between the Welsh colleges and Welsh industry. In his research published in 1972 on the connections between universities and industry, Michael Sanderson was critical of the Welsh University movement, and notes the movement's failure to live up to its claims

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[285] Argles, p. 43.
[286] Charle, pp. 61-2.
[287] Charle, p. 62.
[288] Maclure, p. 119.
[289]J., Gwynn Williams, *The University of Wales 1839-1939, Volume 2* (Cardiff: University of Wales Press, 1997), pp. 64- 92.
[290] Swansea University Library Pamphlets, reference code: W/ LD – W/ LF1145, *Report to the Treasury of the Committee on the University of Wales and the Welsh University Colleges* (London: HMSO, 1909), pp. xiv-xviii.

of establishing an institution which would serve Welsh industries.[291] Sanderson cites examples of how research conducted at the various science departments at the three colleges before 1914 was of little relevance to industry. Pre-war research in chemistry at Aberystwyth was 'insignificant.[292] On the other hand, Bangor College's failure in its efforts to develop educational connections with its nearest industry the slate quarries was partly due to the quarry owner's disinterest in supporting the creation of mining and quarrying studies at the institution.[293] Yet, Sanderson concludes that the main factor underpinning the two northern colleges disengagement from industry, was that the colleges' regarded their role as cultural rather than economic.[294] It is clear that pre-1914 the colleges at Aberystwyth and Bangor had intentions of working with local industries, and important collaborations were established between the colleges and specific local industries.[295] The creation of research projects at Aberystwyth and Bangor colleges that studied the falling crustacean and fish populations due to river pollution were recognised and extended outside of the region of Wales.[296] Moreover, a network had been established between the Zoology department, the local authorities and the local fishing industry, with the agencies collaborating on marine research.[297] The Zoology department went on to conduct further research on crustacean populations in England at the lobster hatcheries on the Beaulieu River at Hampshire.[298]

While both colleges would establish science departments that would benefit the fishing and agriculture industries outside of Wales, the development of agricultural studies by James Johnston Dobbie (1852-1924), Professor of Chemistry at Bangor College influenced the application of academic science. Dobbie created a research structure within the department that would have implications not only for a regional industry but would have an impact at a national level.[299] The Bangor agricultural

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[291] Sanderson, *The Universities and British Industry*, pp. 122-27
[292] Sanderson, *The Universities and British Industry*, p. 132
[293] Williams, *The University Movement in Wales*, p. 110.
[294] Sanderson, *The Universities and British Industry*, p. 145.
[295] Swansea University Library Pamphlets, Box no. W/LD – W/LF 1145, reference no. W/LF 1145, *Report to the Treasury of the Committee on the University of Wales and the Welsh University Colleges* (London: HMSO, 1909), p. xviii.
[296] Williams, *The University Movement in Wales*, p. 358.
[297] Swansea University Library Pamphlets, reference no. W/LF 1145, *Treasury Report on the University of Wales*, p. xviii.
[298] Sanderson, p. 132.
[299] Paul Brassley, 'Agricultural Science and Education' in *The Agrarian History of England and Wales volume VII, Part One,* ed. by Edward John T. Collins (Cambridge: Cambridge University Press, 2000), p. 631. Alex Lauder, 'Sir James J. Dobbie, F.R.S', in *Nature* 114 (9 August 1924), 198-199 https://www.nature.com/articles/114198a0 [accessed 5 February 2019].

scheme became the blueprint for schemes set up in educational institutions across Yorkshire and Northumberland, as well as at Durham.[300] The department's success was made official by a statement of the Inspector of the Board of Agriculture, who declared the agricultural course as 'forming a type on the line of which it may be feasible to organise systematic agricultural education throughout the kingdom.'[301] The scheme originated in 1885 when Dobbie initiated comprehensive field experiments on manuring practices across North Wales and arranged a series of lectures for local farmers. This initiative developed into a department of Agriculture at Bangor College that was part funded by County Councils across North Wales. The employment of a fulltime lecturer, D. A. Gilchrist (1860-1927) in 1888 and a grant of £200 from the Board of Agriculture confirmed the development.[302]

Initially the department of Agriculture had limited facilities, and the lack of a college farm was an obstacle to conducting valuable research and theoretical teaching.[303] The research facilities of the department were greatly enhanced in 1897 with the lease of a 358 acre farm from Sir Richard Bulkeley (1862-1942) and a government grant to transform the buildings into a research facility.[304] It was advantageous for the department that the 1890s was a period when state funding was made available for scientific research into the problems of agriculture, which was a response to the agricultural depression of the 1880s and 1890s.[305] By 1901 agricultural science at both Welsh colleges would include a specialised syllabus including entomology and bacteriology.[306] Bangor College continued with its focus on scientific developments in agricultural science through the early decades of the twentieth-century, appointing advisors in agricultural chemistry and botany in 1911.[307] Government grants were also awarded for academic research into the fishing industry, as the Zoology department at Aberystwyth College in 1912.[308] In addition, Aberystwyth's sister

[300] Dobbie, p. 4.
[301] Dobbie, p. 4.
[302] Salmon Collection (129), Dobbie James J., *Agricultural Education in North Wales* (Bangor: Jarvis & Foster, 1894), p. 3.
[303] J., Gwynn Williams, *The University College of North Wales: Foundations 1884-1927* (Cardiff: University of Wales Press, 1985), p. 168.
[304] Williams, *The University College of North Wales*, p. 168. Williams–Bulkeley baronets, https://ipfs.1o/ipfs.../wiki/williams-Bulkeley_baronets.htm [accessed 28 February 2019].
[305] Sanderson, *The Universities in the Nineteenth Century*, pp. 188-89.
[306] Special Collections and Archives, Cardiff University Library, *The Calendar of the University of Wales 1900-1901* (Newport: Mullock and Sons, 1901), p. ixxxv.
[307] Williams, *The University College of North Wales*, p. 75.
[308] Sanderson, p. 132. The grant supported two research projects: the study of the local mussel industry the Cardigan Bay crab and lobster populations. the study of local salmon and trout numbers.

college at Bangor pioneered notable research projects which benefited the North Wales fishing industry before the First World War.[309] The research led to an improvement to mussel and oyster cultivation in the Menai Straits, as well as the preservation of the Conwy mussel and sparling fisheries.[310]

Agricultural research became a major topic of debate during the Great War, when concerns regarding the efficiency of food production were raised by Francis Dyke Acland (1874-1939), Parliamentary Secretary of Agriculture, in the debate on the second reading of the Repeal Bill in the House of Commons in 1916.[311] There was added urgency to the debate by the drastic shortage of foods being imported into Britain during the war prompting the government to introduce a food production campaign in 1917, with the purpose of increasing the output of grain and potatoes from British farms.[312] Acland believed that for the farming industry to be more productive, it was essential that there was co-operation and trust between scientists and administrators as well as between farmers and landowners.[313]

Acland's concept of a collaborative network working together with a mutual aim of modernising British agriculture was not a new idea. The idea had already been initiated in the late nineteenth-century by Bangor College, and had been successfully practised in the farming communities of North Wales.[314] The effort that was needed to cultivate collaborations between Welsh-speaking farmers who worked their farms using ancestral traditions, and academics who were often monoglot Englishmen who proposed modern methods, must not be underestimated.[315] Problems between the two cultures often arose as Welsh culture, and especially the Welsh language were misunderstood and derided by many English academics and intellectuals. This situation was clearly illustrated by the opinion expressed in 1866 by the editor of *The Times*, John Thadeus Delane (1817-1879), who wrote that the Welsh language as 'the curse of Wales' and 'an obstacle to the march of intellect, prosperity, and progress'.[316] Such views were matched in Wales

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[309] Williams, *The University Movement in Wales*, p. 358.
[310] Williams, *The University Movement in Wales*, p. 358.
[311] Edith H., Whetham, 'The Agriculture Act, 1920 and its Repeal-the 'Great Betrayal'', *The Agricultural History Review*, vol. 22 (1974), 36-49 (p. 48).
[312] Whetham, p. 36.
[313]Whetham, p. 48.
[314] Dobbie, p. 4.
[315] Williams, *The University College of North Wales*, pp. 358-59.
[316] Morgan, pp. 3-4.

by a rising national consciousness and self-respect in the language and culture.[317] The importance that Bangor College attached to its scientific research in agriculture is highlighted in the college's response to the Royal Commission.[318] In a statement sent in 1919 to the Prime Minister, David Lloyd George (1863-1945), the college accused the commissioners of failing to recognise that agriculture was Wales's greatest industry.[319] While the statement is an exaggeration at the expense of the heavy industries in South Wales, it did allude to the national concern of effective food production and food shortages.

The University of Wales's engagement with industry did not develop substantially with the creation of the institution's third college which was established at Cardiff in 1883. Such difficulties experienced by the university college at Cardiff in attracting industrial partnerships was partly due to the length of time it took for the region to acknowledge the importance of scientific and technical education.[320] It is important to note that this was not just a Welsh problem. The reluctance of industries to work with universities was partly resolved in England by the institutions developing specific research and teaching programmes, which connected with local and national industries.[321] However, Welsh educationalists recognised that unlike some of their counterparts in England the Welsh colleges were not modernising their administration or adapting their courses to modern industrial requirements.[322] Yet, the difficulty faced by researchers over the lack of public engagement and concern regarding the necessity for industrial research continued to be problematic. So much so that by 1915 the problem of public disengagement with science was identified in the White Paper (Cd8005) of July 23, 1915 compiled by Arthur Henderson (1863-1935), the President of the Board of Education.[323]

The reason behind the difficulty of engaging the Welsh public with scientific research was not due to a disinterest in higher education, but with the acceptability of

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[317] Brian Howells, 'Modern History' in *Wales A New Study* ed. by David Thomas (London: David & Charles, 1977), p. 116.
[318] Williams, *The University College of North Wales*, p. 387.
[319] Williams, *The University College of North Wales*, p. 387.
[320] Special Collections and Archives, Cardiff University Library, Ref no: FWG12.U, Chrimes, S. B., 'Part One Government, Administration and Finance', in *University College Cardiff. A Centenary History 1883-1983* ed. by S. B., Chrimes (unpublished), p. 53.
[321] Sanderson, *The Universities and British Industry*, p. 389.
[322] Salmon Pamphlet Collection (129), *The Future of Education-What Shall it be?* (Cardiff: Western Mail Ltd., 1917), p. 7.
[323] Swansea Museum Library, Box no. 88, item no. 79 / 23, Harold H. C. Carpenter, *The Policies involved in the organisation of Scientific Research by the State* (Cardiff: University of Wales Press, 1931), p. 18.

science as an area of study.[324] Many Welsh parents preferred their children to study the humanities, as parental ambitions were directed towards professions in the church or in teaching. The belief that such professions had a moral aspect attached to them against a scientific profession with its potential dangers of leading to a 'selfish and detached career', was prevalent in Wales up to and during the First World War. The consequences of this bias resulted in very few numbers of Welshmen becoming qualified to fill the higher posts in the 'industrial community'. Evidence of the continuance of this view is reflected in the fact that the numbers of students studying science in the constituent Colleges did not increase from the early years of the 1900's through to the end of the war.[325] The number of graduates remained between 20 to 25%**.** The figures given for the University College, Cardiff illustrated that over a 12-year period, nearly all the 250 graduates from the Metallurgy, Engineering and Mining Departments obtained positions in England or the colonies. The principle of the University College, Cardiff, Ernest Howard Griffiths (1851-1932), warned that the lack of science graduates was 'the most pressing need of our time'.[326]

Historically, the indications had been positive for the successful establishment of science teaching and research at the Cardiff institution, as its first principal John Viriamu Jones (1856-1901), was an enthusiastic promoter of scientific and technical education.[327] In his previous appointment as Principal of Sheffield University Jones' determination to advance scientific and technical education was noted in his proposals to unite the various higher education institutions in Sheffield.[328] In one section the report detailed how the establishment of a Faculty of Pure and Applied Science could incorporate a comprehensive range of specialised science and technical disciplines.[329]

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[324] E. H., Griffiths, 'Scientific Education and Welsh Industries' in *The Transactions of the Honourable Society of Cymmrodorion, session 1916-17* (London: issued by society, 1918), p. 198.

[325] Griffiths, pp. 198-207.

[326] Griffiths, pp. 198-207. For contemporary reading on social attitudes to higher education in Wales from 1900-1916 see: Central Welsh Board, *Today and Tomorrow in Welsh Education: a referendum addressed to Welsh education authorities by the Central Welsh Board: an analysis of current problems, with some suggestions for their solution* (Cardiff: Central Welsh Board, 1916). Salmon Collection (16), Swansea University Library, John E. Southall, *The Future of Welsh Education: being a review of some of the existing forces affecting education in Wales from the point of view of national individuality* (Newport: John E. Southall, 1900).

[327] Williams, pp. 80-1. Edgar William Jones, 'Jones, John Viriamu (1856-1901), first principal of the University College, Cardiff)' *Dictionary of Welsh Biography,* https://biography.wales [accessed 09 December 2019].

[328] Arthur W., Chapman, *The Story of a Modern University* (London: Oxford University Press, 1955), pp. 90-1.

[329] Chapman, pp. 90-1. Viriamu Jones' vision of a united college at Sheffield would be kept alive by his successor W. M. Hicks.

Principle Jones's visions for Sheffield would be re-invested in his ambitions for the constituent university college at Cardiff. However, such aspiring plans would have an unintentionally negative impact on the relations between the college and local industry. During the early years of the institution a wide range of disciplines were established, so that by 1904 twenty-three departments had been established at the college. The excessive diversification of the institution would proceed to have profound consequences on its limited funds and space, and by over-reaching its educational provision the college failed to develop areas of excellence. Perhaps specialised departments would have had more of a chance of attracting sceptical Welsh industries.[330]

Cardiff College's failure to develop connections with regional industries, was also acknowledged to be due to industrial attitudes towards university education.[331] The College declared that, 'industry was slow to appreciate that maths, mechanics, and physics were the basis of all engineering'.[332] The idea that science and technology were not linked was one that was accepted by many industrialists and scientists.[333] Historically, contemporary cultural attitudes towards scientists, and the place of science and technology within society, drove the debate regarding the relationship between the two disciplines. However, as nineteenth century industrial expansion continued, the question of state scientific funding became part of the debate. Those scientists who argued for state funding believed that science was essential to industrial progress, and therefore science and technology were intrinsically linked, albeit in a hierarchical capacity. The ranking system element of scientific and technical connections continued into the twentieth century, as science became both an academic and an industrial profession. There was an attitude amongst many scientists working in academia that the work of scientists working in an industrial setting was not quite 'pure' science.[334]

The situation at the University College, Cardiff was not helped by industrialists believing that universities should only concentrate on teaching students the business of an industry, not practical skills. Employers were then disappointed when they employed

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[330] Sanderson, *The Universities and British Industry*, p. 136.
[331] Chrimes, p. 53.
[332] Chrimes, p. 53.
[333] Peter J., Bowler and Iwan Rhys Morus, *Making Modern Science* (Chicago and London: The University of Chicago Press, 2005), p. 412.
[334] Bowler and Morus, p. 412.

graduates who only performed routine duties as well as non-graduate employees.[335] When leading representatives of the main industries of Wales were asked to send representatives onto the Councils of either the colleges or university, they remarked: 'Why should we help you? Our interests are entirely different. You are chiefly engaged in turning out teachers and preachers, how are we affected thereby?'[336] While this is an over-simplification, the statement does expose the negative attitude which was felt by certain influential industrialists towards the university and the colleges. The promotion of these attitudes had a further consequence, one of having few leading industrialists on the colleges or university councils.[337]

The lack of engagement with Welsh industry by the colleges of the University of Wales was noted by a Royal Commission appointed during the First World War.[338] While the consequences of disengagement from industry by the colleges of Aberystwyth and Bangor did not have a marked effect on the economy of Wales, the failure by the college at Cardiff to connect with industry had a serious consequence.[339] The situation was of immediate concern to the commission, as at this time Wales was an important economic region, and played a central role in the success of the British economy due to its coal-mining and metallurgical industries.[340] Therefore, the success and stability of Welsh industry was inter-connected with the type of education provided by its university. The actions, previously noted in the chapter, of both the University and the industrialists seem to point to a lack of awareness of their mutual responsibility.[341] Yet, these conversations were not new, as the frustrations of the Cardiff principal, Ernest Howard Griffiths (1851-1932) on the subject can be perceived in the published pamphlet, *The Duty of University Colleges in regard to Higher Technical Education* as early as 1903.[342]

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[335] Salmon Collection Pamphlet (129), E. H., Griffiths, *Industry, Science and Education with Special Reference to the Conditions in South Wales and Monmouthshire* (Cardiff: Roberts & Co., 1917), pp. 53-54.
[336] Griffiths, p. 54
[337] Griffiths, p. 54.
[338]Royal Commission on University Education in Wales, *Final Report of the Commissioners* (London: H.M.S.O., 1918), p. 27.
[339] Sanderson, *The Universities and British Industry*, pp. 134-35.
[340] Gareth Elwyn Jones, 'Policy-Making in Welsh Education: A Historical Perspective, 1889-1988' in *Education Policy-Making in Wales,* eds. Richard Daugherty et al (Cardiff: University of Wales Press, 2000), p. 55.
[341] Jones, p. 55.
[342] Salmon Collection Pamphlets (55), E. H., Griffiths, *The Duty of University Colleges in regard to Higher Technical Education* (Cardiff: Tudor Printing Works, 1903).

A prolific writer on education and industry, Griffiths recognised that industries including the business of coal-mining were becoming increasingly scientific and complex, and therefore needed mining engineers and managers with a thorough scientific education.[343] Furthermore, Griffiths stated that the funds to provide such education in Wales were woefully inadequate.[344] Indeed, financial endowments from the mining industries to Cardiff College were few.[345] An underlying reason for this limited financial support, was that although the wealth of the major coal companies was substantial, they were reluctant to financially support Cardiff College due to their capital being absentee capital. Another factor was that for some coal owners their connections with Wales was only a commercial one, and an absence of personal connections to the institution resulted in a lack of philanthropic endowments.[346]

A later publication of three lectures by Principal Griffiths addressed the relationship between 'industry, science and education'.[347] There was a need for constructive academic and industrial relationships, as both the mining and tinplate industries had significant problems, including serious safety issues in the mines.[348] The mining department at the South Wales College which had been established in 1891 with Sir William Galloway (1840-1927), as Head of Department, failed to provide specific teaching and research which could have provided the science to alleviate some of these issues. There was so little progress in establishing and conducting the necessary research to support the mining industry at the university college, that the owners of the South Wales coal companies pioneered their own facilities. The mine owners established their own mining school, the South Wales and Monmouthshire School of Mines at Treforest in 1912.[349] Contrary to the mine owner's lack of financial support for the university college, the coal-owners spent approximately £250,000 on their mining school between the years 1912 and 1916.[350]

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[343] Griffiths, pp. 5-6.
[344] Griffiths, pp. 5-6.
[345] Williams, p. 349.
[346] Williams, p. 349.
[347] E.H.D., 'Industry, science and education', *Welsh Outlook* vol.4 (1917), 323 http://journals.library.wales/search [accessed 23 December 2017]
[348] Sanderson, *The Universities and British Industry*, pp. 134-35.
[349] Sanderson, *The Universities and British Industry*, pp. 134-35. The School of Mines had a continuous history as an institute of higher education through developments into a college, polytechnic and today is the University of South Wales.
[350] Williams, p. 348.

The establishment of the mining school would have a detrimental effect on the number of students studying at the Cardiff institution. Fewer students enrolled each year at the college to study mining, and by the eve of the First World War the Department of Mining at the University College, Cardiff had just one student.[351] It is not surprising that a pamphlet published by the Welsh newspaper, the *Western Mail* concluded that the complacency of the Welsh colleges tainted the reputation of the Welsh university, as it seemed 'indifferent alike to present national needs and future national development'.[352] However, Griffiths did acknowledge the connections which were built between the School of Mines and the University College, Cardiff.[353] By 1917 fulltime students attended courses which consisted of modules shared between the two institutions. With some students returning to the university to undertake specialist research, Griffiths declared the course to be 'an example of close union between science, industry and education'.[354]

Consolidating connections between academic science, industry, and military requirements

Whereas the success of the mining school established at Treforest and its sister school at Crumlin (1914) were acknowledged by the 1916 Royal Commission on university education in Wales, it was noted by the enquiry that it was the failings of both the coal companies and the University College that instigated their foundation.[355] The 1916 Royal Commission was regarded by the promoters for a university college at Swansea as the final opportunity to establish such an institution in the region.[356] Aspects of the Commission that had a bearing on the creation of the University College, Swansea will be discussed later in the chapter. However, the Royal Commission was instigated during a period of national crisis, the First World War. The increasing demands of the military conflict ensured that the commission's debates and discussions related to the need for closer academic and industrial co-operation. The outbreak of war on 4 August 1914

[351]Sanderson, *The Universities and British Industry*, pp. 134-35.
[352] Salmon Pamphlet Collection (129), *The Future of Education*, p. 9.
[353] Salmon Collection Pamphlets (129), Griffiths, E. H., *Industry, Science and Education* (Cardiff: Roberts & Co., 1917), p. 62.
[354] Griffiths, p. 62.
[355] Royal Commission on University Education (1918), p. 29.
[356] Dykes, 'The University College of Swansea'. p. 349.

took the academic world by surprise, as university staff and students were taking their summer vacation with many scholars vacating in Europe.[357]

Some educational institutions were slow to recognise the full extent of wartime conditions, as illustrated by the inaction of the Senate of Bangor University College in terminating its contact with the University of Berlin.[358] It was only in 1915 that Bangor university college resolved to stop sending the Berlin institution a free copy of the college *Calendar*. Furthermore, the collapse of relations between the two countries had a serious impact on the college's academic study, especially with practical chemistry classes as Germany was the main source of chemicals used in academic research.[359] The research of Tomás Irish reveals the complexities and variances of how the outbreak of war affected the academic communities of two of universities of the nations involved, Britain and France.[360] British scholars studying and researching abroad suddenly found themselves working in 'enemy' territory and had to return to their home countries. As these men (and they were mostly men) were returning to their home institutions, younger scholars and students were enlisting for the front.[361] At the start of the 1914/15 academic year, the degree to which students had enlisted became apparent.[362] Numbers of students at the University College of London had halved, and Manchester had lost a third of its student intake. At Oxford, the numbers were profound, with only 369 students remaining of the 3,097 individuals who had left for their summer vacation the previous July.[363]

The students at the three colleges of the Welsh University were also drawn into the national call to arms, with the number of students who were commissioned at Aberystwyth amounted to 63% of its student population, 56% at Bangor, and 53% at Cardiff.[364] Dr W. Mansergh Varley, the principle of the Swansea Technical College noted that the call up deprived the Welsh colleges of its senior students.[365] The lack of senior students affected the development of providing any university level teaching at

[357] Irish, p. 16.
[358] Williams, *The University College of North Wales*, pp. 325-36.
[359] Williams, *The University College of North Wales*, pp. 325-36.
[360] Tomás Irish, 'Fractured Families: Educated Elites in Britain and France and the Challenge of the Great War' *The Historical Journal,* 57 (2014), pp. 509-530.
[361] Tomás, '*Fractured Families'*, p. 514.
[362] Pietsch, p. 126-27.
[363] Pietsch, p. 127.
[364] Williams, p. 114.
[365] Richard Burton Archives, Swansea University Library, reference no. Box no. 666, Swansea University Misc, 3 of 3, Swansea Borough Council, *Royal Commission on University Education in Wales, Proofs of Evidence.* (date unknown), p. 30.

the Technical College, a disruption which continued throughout the war. Yet, not all students were eager to enlist, as questions and reservations regarding the conflict continued to be discussed on campuses throughout the duration of the war.[366] This was particularly prevalent at Cambridge University, where dissenting students became conscientious objectors once conscription was introduced in 1916. The decrease in student numbers had an adverse effect on the university campus: reduced numbers of staff and the absence of students meant that lectures were often cancelled, and those lectures that did take place were given to modest audiences.[367] Furthermore, the community aspect of the university campus was also affected by the protracted conflict, as academic communities had to come to terms with the unprecedented death rate of colleagues.[368]

The outbreak of the First World War drew attention to the consequences of neglecting specific areas of scientific education which were relevant to the war effort in Britain. By 1916 there was a widespread realisation by some within British society that the country was perilously dependent on German industries for many imports that were essential to British defences.[369] Britain faced a severe shortage of synthetic dyes, pharmaceutical products, optical glass, and chemicals which were imperative for the manufacture of explosives.[370] These products had been previously obtained not only from European countries that were now 'enemy' territories, but from Spain and the United States where trading routes were under threat.[371] This worrying situation was discussed by many scientists in 1914, including the physician Sir William Osler (1849-1919), who in an address on the relationship between science and war highlights Britain's disparity with Germany by declaring:

> In forty years Germany made science infiltrate every activity of her life ... she can be independent of the importation of nitrates by the synthetic manufacture of nitric acid, it will pay her a thousandfold the millions she has spent in promoting the interdependence of science and commercial technology.[372]

[366] Irish, *'Fractured Families'*, pp. 522-23.
[367] Irish, '*Fractured Families'*, p. 514.
[368] Irish, pp. 61-62.
[369] Berdahl, p. 56.
[370] Pietsch, p. 133.
[371] Pietsch, p. 133.
[372] William Osler, *Science and War: an address delivered at the University of Leeds Medical School* (Oxford: Clarendon Press, 1915). In this address Osler also warns of the expected high death rate from modern warfare.

This assessment of German industrial hegemony and quasi monopoly was shared with dismay by the British steel industry and added to the industry's problems of limited investment and American competition in foreign markets.[373]

A further complication to product shortages was the productive deficiency of British industries. The strain of directing vital heavy industry production towards the war effort put such industries as steel and tinplate processing under immense pressure.[374] The response to wartime demands for steel required expanding production and the acquirement of adequate numbers of skilled workers, managers, and experts to train the workforce in new techniques.[375] This was particularly apparent by the lack of skilled men within the industry who could train employees to make the change from working tinplate bars to working high carbon steel. Their numbers were so few that the French government offered to send experts to train the workforce at the industrial plants in South Wales.[376] This was the type of industrial innovation that became problematic due to the inadequacies of scientific higher education in the industrial areas of South Wales. Furthermore, there were difficulties in achieving a rapid increase in production, as key areas in steel-making processes such as South Wales had already suffered with plant closures and the dispersal of skilled labour due to the impact of tinplate imports from America.[377]

A month after Osler's address, the Royal Society established a war committee to offer scientific advice, however there was very little response from either the government or the armed services.[378] Throughout the war the scientific community's historic accusation of the ignorance of politicians and government civil servants in relation to scientific issues continued to resurface.[379] However, in 1916 the tensions between the scientific community and the government were heightened to such an extent that action was taken. Increasing frustration over the extent of the scientific ignorance of not only civil servants, but also the highest Ministers of State, led to over thirty prominent scientists creating a committee on the Neglect of Science who then proceeded

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373 Warwick Modern Records, University of Warwick, reference no: S125a / 23a, Memorandum of the South Wales Siemens Steel Association (1915?), pp. 3-5.
374 Modern Records Centre, Warwick University, reference no: S125a / 23a, *Memorandum of the South Wales Siemens Steel Association* (1915?), p.3.
375 Modern Records Centre, Warwick University, reference no: MSS.36 / 2003 / 209, p. 5.
376 MRC, reference no: MSS.36 / 2003 / 209, p. 5.
377 MRC, reference no: S125a / 23a, p. 3.
378 Pietsch, p. 129.
379 Frank M., Turner, 'Public Science in Britain, 1880-1919,' *Isis*, 71 (1980), 589-608, (p. 605).

to sign a petition.[380] The committee's petition was published in the *Times* on 2 February 1916, and declared emphatically that:

> It is admitted on all sides that we have suffered checks since the war began, due directly as well as indirectly to a lack of knowledge on the part of legislators and administrative officials of what is called 'science,' or 'physical science' By these terms we mean the ascertained facts and principles of mechanics, chemistry, physics, biology, geography and geology.[381]

Yet, there were signs of engagement. The British government responded to these concerns by appointing a committee of the Board of Trade to identify problems and then to co-ordinate the appropriate responses.[382]

One response was the establishment of the Ministry of Munitions in June 1915, which drew the universities into war-related research.[383] The ministry was created to address munitions shortages, but it soon became apparent that the laboratories of the universities along with the expertise of their employees had a vital role to play in the war effort.[384] The scientific demands of the conflict brought the state, universities and industries together to work for the war effort, with research conducted within the university sphere becoming a crucial element.[385] Scottish universities and the civic universities in England whose close links with industry had already contributed research to industries as diverse as chemicals and metallurgy to soap and beer.[386] Whereas national commercial and military needs during the war, ensured that academic contributions to industry became more urgent and focused.[387] As such, the institution's role as a research facility gave the civic university its first widely recognised national role, and one which would have implications for the future direction of the university.

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[380] Memorandum, 'Neglect of Science A Cause of Failures in War', *The Times*, 2 February 1916, p. 10. The following scientists attached their names to the Neglect of Science Memorandum: Sir T. Clifford Allbutt, Dr Henry E. Armstrong, Lord Berkeley, Prof. Rowland Biffen, Prof. Gilbert C. Bourne, Louis Brennan, Dr J. D. Ewart, Prof. J. S. Fleming, Prof. A. G. Green, Prof. J. W. Gregory, Prof. E. H. Griffiths, Prof. S. J. Hickson, Prof. L. E. Hill, Prof. J. P. Hill, Sir E. Ray Lankester, Dr P. Chalmers Mitchell, Sir Henry Morris, Sir William Osier, Hon. Sir Charles A. Parsons, Prof. Karl Pearson, Prof. W. H. Perkin, Dr John Perry, Dr J. C. Phillip, Prof. E. B. Poulton, Sir William Ramsay, Lord Rayleigh, Major Sir Ronald Ross, Dr A. E. Shipley, Prof. E. H. Starling, Prof. J. Arthur Thomson, Sir Edward Thorpe, Sir William Augustus Tilden, Prof. H. H. Turner, Sir John Williams, Prof. T. B. Wood.
[381] Memorandum, 'Neglect of Science', *The Times*, p. 10.
[382] Berdahl, p. 56.
[383] Pietsch, p. 129.
[384] Pietsch, p. 129.
[385] Lyons, p. 128.
[386] Patrick Nuttgens, 'Technology and the University', in *Universities, Society, and the Future* ed. by Nicholas Phillipson (Edinburgh: Edinburgh University Press, 1983), pp. 182-83.
[387] Nuttgens, pp. 182-83.

University laboratories were appropriated by the state, and their research was focused towards solving scientific problems posed by the war.[388] While individual universities conducted their own research programs, the challenges of war time encouraged the necessity of collective research.[389] Science departments from universities were involved in projects from across Britain including the colleges of the University of Wales. While several universities were engaged to produce toluol, the 'mother substance' of the explosive trinitrotoluene (TNT), it was a student D. C. Jones studying chemistry at Bangor University College who established a test to determine the exact degree of purity in the substance.[390] The test was officially adopted by the Department of Explosive Supply, although the actual manufacture of TNT was undertaken by the private sector.[391]

The lack of qualified chemists continued to be of such concern that Britain appealed to the United States, and to those parts of the British Empire for men with industrial chemical training.[392] The Ministry of Munitions not only needed trained chemists to assist with the making of chemicals needed for explosives, but also skilled engineers who could produce the product on an industrial scale.[393] The seriousness of the lack of skilled chemists in Britain was discussed retrospectively with the Official Secretary at Australia House by Arthur Edgar Leighton (1873-1961).[394] Leighton was an English chemist whose success in establishing and expanding the Australian munitions industry brought him to the attention of the British authorities. In 1914 Leighton was requested by the British government to return and undertake war work. In a letter dated 12 June 1918 to the Australian Official Secretary, Leighton stated:

> It very soon became clear to me that this country had already absorbed the British trained chemists, and that to staff the new explosives factories then under construction it would be essential to bring men from the Dominions.'[395]

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[388] Irish, p. 47.
[389] Irish, p. 47.
[390] J. Gwynn Williams, *The University College of North Wales*, p. 327.
[391] Sanderson, *The Universities and British Industry*, pp. 220-21.
[392] Pietsch, pp. 133-34.
[393] Pietsch, pp. 133-34.
[394] Dr Julian Tudor Hart Collection. South Wales Miners Library, Reference no: Q93.C66, Ian D. Rae 'Chemists at ANZAAS: Cabbages or Kings?' in *The Commonwealth of Science. ANZAAS and the Scientific Enterprise in Australasia 1888-1988,* ed. by Roy Macleod (Oxford: Oxford University Press, 1988), 166-195 (p. 175).
[395] Rae, p. 175.

Specially organised committees in Australia selected chemists from across the Australian states, drawing them from their roles in government, industry, and educational institutions to work for the war effort in Britain.[396]

The response by universities in Australia and New Zealand was positive, with the mobilization of many chemistry lecturers and research students to Britain. Approximately 130 of the 250 chemists who began working for the Factories Branch of the Ministry of Munitions' Department of Explosives supply were from Australasian academia.[397] In fact, due to their expertise in working at an industrial capacity, some of the Australian scientists took charge of whole sections of the British chemical industry.[398] The large-scale chemical operations which became necessary during the war ensured that many scientists gained experience of working in industry, thereby obtaining practical skills that few academically trained British scientists had the opportunity to obtain pre-1914.[399] On both sides of the conflict science was used for military application, especially in the development and production of more effective explosives and in Germany the application of a new weapon, poison gas.[400] The development of this new weapon was an example of how the demands of war hastened research through unlikely collaborations. The inventor of the Haber-Bosch process and pioneer of weaponizing poisonous gases, Fritz Haber (1868-1934) was a chemist, and his organisation the Institute for Physical and Electrochemistry at Dahlem, Berlin worked closely with industry to set up the chemical warfare programme.[401]

Haber had a link with the chemistry department at the University College of Swansea through his close association with the head of department, J. E. Coates.[402] As a former student and associate, Coates was asked by the Chemical Society to give the memorial lecture to Haber in 1934. In fact, Coates' 'careful and conscientious' research revealed the complexity of Haber's commitment to chemical warfare and that the militarisation of the project had proved to be problematic for Haber.[403] The complexity of early academic and military collaborative research was later highlighted by Haber's

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396 Macleod, p. 175.
397 Pietsch, pp. 133-35.
398 Pietsch, pp. 133-35.
399 James Taylor, *The Scientific Community* (London: Oxford University Press, 1973), pp. 24-25.
400 Bowler and Morus, pp. 465-67.
401 Bowler and Morus, pp. 465-67.
402 L. Fritz Haber, *The Poisonous Cloud. Chemical Warfare in the First World War* (Oxford: Clarendon Press, 1986), pp. 3-4, 130.
403 Haber, p. 291.

son, Dr L. F. Haber in 1975 in a lecture on the history of gas warfare, noting that the practice was:

> Rendered more complex by the necessity of linking literature surveys with group research and couple both to the manufacturing capability of the chemical industry and the demands of an unscientific customer, the Army, which usually had only a very general notion of what it wanted.[404]

Britain and France also developed a chemical weapons programme in the early years of the conflict, with each country establishing strong links between chemical producers, scientists and the military.[405] Coates' memorial lecture to Haber was well received by the audience of British chemists even though he ignored advice from the physical chemist Harold B. Hartley (1878-1972) to not completely exonerate Haber from his role in the use of gas warfare.[406]

Chemistry was not the only scientific discipline whose specialism became essential to the war.[407] Other scientific disciplines most notably geology and physics played an increasingly active role in the campaigns of both sides of the war. The development of trench warfare required geological expertise especially in compiling detailed scientific maps. The narrative of the involvement of British geologists during the conflict in many ways mirrored the experience of the chemists, with Britain slow to engage with academic geological expertise. In contrast to the prompt mobilisation of German geologists in early 1915, the presence of British geology at the Western Front consisted of one man, William Bernhard Robinson King (1889-1963). King was supported by French and Belgium geologists, until mid-1916 when he was joined by the Australian Tennett William Edgeworth David (1858-1938), and other colonial geologists. David's company of mainly Australian geologists were responsible for all the British geographical work on the Western front. Through necessity the war had created new

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[404] Swansea University Library Pamphlets, reference code: JX5133.C3, Haber, Dr. L. F, *Gas Warfare 1915-1945. The Legend and the Facts* (London: University of London, 1976), p. 8. For further reading on contemporary attitudes to chemical warfare during World War see: J. B. S. Haldane, *Callinicus or A Defence of Chemical Warfare* (London; Kegan, Paul, 1925). (J. B. S. Haldane was the nephew of R. B. Haldane, the pre-war army minister and educationalist.

[405] Agar, pp. 102-03.

[406] Haber, p. 291. Harold Hartman was head of the Inter-Allied Mission which inspected the German chemical factories after the Armistice, https://www.icheme.org>about-us>people>presidents>sir-harold-hartley

[407] Pietsch, pp. 135-37.

opportunities for transnational scientific networks, and those connections that developed would last through the war and into peacetime.[408]

Re-affirming the place of science in the University of Wales

The complexity of the public science debate during World War I and the conversations held within the scientific community on the condition of British science, specifically on the nature, funding and scope of an emerging scientific research policy are explored by numerous historians. In his research on the origins of the Department of Scientific and Industrial Research (DISR) Andrew Hull explores the differing views and ambitions within the scientific community and defines his argument using the Frank Turner's concept, 'public science'.[409] Turner's proposed this concept in 1980 as an aid for historians to navigate the constantly changing public forum of science during the nineteenth and early twentieth centuries.[410] A memorandum sent by the committee of the Board of Trade in December 1914 to the Board of Education pointed out the failure of the universities to establish and promote science modules.[411] Further discussions expressed urgency and frustration as noted by a quote from an anonymous letter to *Nature* (20 May 1915), which argues that:

> Among the changes which will follow the war, whatever the issue may be, the reorganisation of scientific effort must find a place. All the after-dinner speeches about the parsimony of the Treasury, and all the complaints in *Science Progress* and at the meetings of the British Science Guild, punctured by what has been brought to light since the war began, mean at least that…only we must have a way which is recognisable and recognised.[412]

In response to criticisms the Board of Education established its own committee, which in turn prepared and published a White Paper on 23 July 1915 creating the DISR.[413]

There were complex opinions within the scientific community regarding the role of the department, with criticism from those scientists who argued that the research agenda

[408] Pietsch, pp. 135-37.
[409] Andrew Hull, 'War of Words: The Public Science of the British Scientific Community and the Origins of the Department of Scientific and Industrial Research, 1914-16' *The British Journal for the History of Science*, vol. 32 (1999), pp. 461-481,
[410] Hull, p. 462. For further reading on public science see, Frank Turner, 'Public Science in Britain, 1880-1919, *Isis*, vol. 71 (1980), 589-608.
[411] Berdahl, p. 56.
[412] Hull, p. 470.
[413] Sabine Clarke, 'Pure Science with a Practical Aim: The Meanings of Fundamental Research in Britain, circa 1916-1950' in *The History of Science Society*, vol. 101 (June 2010), 285-311 (p. 289).

should be kept under the control of scientists.[414] However extensive the debate was around the DSIR and its remit, the department became responsible for awarding research fellowships and studentships and encouraged initiatives between research associations and private industry.[415] More significantly for the development of academic science, the department became the main conduit through which university science departments accessed government aid for research.[416] The close ties which had developed between industry and state sponsored academic research continued and developed in the post-war period. Subsequently the university became recognised as the institution which would not only conduct such research, but which would train future scientists and engineers.[417]

While the establishment of the DSIR facilitated funding for scientific research and offered support for student researchers, it did not address the limited numbers of students applying for science courses. The lack of adequate numbers of science graduates, and a further shortcoming of providing research training for most of the students resulted in the lack of research scientists across Britain.[418] Graduate results for the Welsh University between the years 1897 and 1907 clearly reflect how the science faculties were failing to compete with the arts and humanities in either attracting students or delivering the appropriate science courses. During this period 298 degrees were awarded to science students compared to 903 degrees in arts and humanities. This disparity continued at the Honours degree level, with only 81 honours degrees awarded to science students compared to 525 in arts and humanities.[419] While the University of Wales had small numbers of students studying science disciplines, this was not an unusual state of affairs when put into context with national science student figures.[420] Leading up to the First World War the national annual figures of 1st and 2nd Class Honours graduates in mathematics, science and technology were as few as 530 a year. It was due to failings such as skilled staff shortages in British industry, that the government initiated a Royal Commission in 1916 to investigate amongst other internal

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414 Clarke, pp. 290-91. For further reading on the relationship between the state and science see: Peter Alter, *The Reluctant Patron: Science and the State in Britain, 1850-1920* (Oxford: Berg, 1987). D. E. H., Edgerton and S. M. Horrocks, 'British Industrial Research and Development before 1945', *Economic History Review,* vol. 47 (1994), 213-238.
415 Berdahl, p. 56.
416 Berdahl, p. 56.
417 Lyons, p. 128
418 Cardwell, pp. 170-71.
419 Thomas, p. 37.
420 Cardwell, pp. 170-71.

institutional issues, whether scientific and technical higher education in Wales was compatible with its significant industries.[421]

There was initial opposition to the desirability of a commission as the country was preoccupied with World War I, and the Welsh University Education Conference made it clear that it opposed the timing of the inquiry.[422] However, all three constituent colleges of the University of Wales had financial problems and there were increasing concerns regarding the efficiency of the university's federal system. Therefore, it was determined that such an important educational investigation should not be left till after the conflict.[423] As one Welsh historian noted that this was a period when the University of Wales had 'its first crisis of confidence.' The political background to the decision to establish the commission in 1916 originated from an advisory committee set up in 1913 chaired by William McCormick (1859-1930), to look into the distribution of exchequer grants to universities and university colleges.[424] This prepared the way for a more detailed review of the University of Wales in the form of a Royal Commission, and institutional development and finance were two of the main issues that initiated its appointment in 1916.[425]

The remit of the Commission was to investigate into the organisation of the University of Wales and its three constituent colleges, the work of the institutions and their connections with other higher education institutions.[426] The Commission was also required to consider any improvements or changes to the University and its Colleges.[427] One of the institutional changes within the University of Wales concerned a proposal to provide medical education in Wales by establishing a medical school at Cardiff.[428] Another proposal was a claim from a delegation from Swansea to upgrade the Swansea Technical College to the status of a university college within the federal system of the University of Wales.[429] This development is discussed later in the chapter. However,

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421 Jones, p. 55.
422 Article (anonymous), 'University Education in Wales. A Royal Commission Appointed' in *The Hospital* (1916), https://pdfs,semanticscholar.org [accessed 8 February 2019], p. 87.
423 David Roberts, *Bangor University 1884-2009* (Cardiff: University of Wales, 2009), p. 30.
424 Roberts, p. 30. 'Sir William McCormick, G.B.E., F.R.S.', in *Nature* (1930), https://www.nature.com/articles/125569a0.pdf [accessed 28 February 2019], pp. 569-571.
425 Eric Ashby and Mary Anderson, *Portrait of Haldane at Work on Education* (Hamden, Conn: Archon Books, 1974), p. 124.
426 RBA, 665 / 4, *Royal Commission on University Education in Wales*, p. ii
427 RBA, 665 / 4, *Royal Commission on University Education*, p. ii.
428 Richard Burton Archives, Swansea University Library, Box no. 665, uncatalogued bundle 4 of 4, *Royal Commission on University Education in Wale*s. *Final Report of the Commissioners* (1918), p. 28.
429 RBA, Box no. 665, *Final Report*, p. 44.

institutional expansion was overtaken by the more pressing matters of finance. The treasury was dissatisfied with the bureaucratic aspect of the control of finances of the individual colleges, and the university was certainly unhappy with the size of the state grants allocated to the colleges.[430]

The 1916 Commission on University Education in Wales stood apart from other enquiries into Welsh education, by its detailed investigations and was regarded by many contemporary educationalists as one of the most scrutinized enquiries made into a higher education institution in the United Kingdom.[431] The commission's committee consisted of individuals from outside the sphere of influence of the University of Wales and its constituent Colleges, but benefited from having individuals with a wide range of experience in academic administration and finance, such as Emily Penrose (1858-1942), Principal of Somerville College, Oxford.[432] Penrose was familiar with the financial situation of the University of Wales, as she had been a member of the Advisory Committee on University Grants which had visited the university's constituent colleges in 1913.[433] The achievements and attained status of Penrose was unusual for a woman within academia during this period, but her intellect and substantial administrative abilities ensured her acceptance in the predominately male world of academic politics.[434]

The appointed members of the committee were all academics or administrators whose various fields of interest were connected to Wales, with two of its members the philosopher, Sir Henry Jones (1852-1922), and the educationalist, Sir Owen Morgan Edwards (1858-1920) being born and raised in Wales.[435] Whether the Welsh connections of Jones and Edwards made them more sympathetic to the position of the Welsh university is difficult to determine. On the other hand, the Commission's appointed chairman, Lord Haldane (1856-1928) was quite vocal in his support of Welsh

[430] Ashby and Anderson, p. 124.
[431] Special Collections and Archives, Cardiff University Library, reference no: FWG12.U, Chrimes, S. B., 'Part One Government, Administration and Finance', in *University College Cardiff. A Centenary History 1883-1983* (unpublished) ed. by S. B., Chrimes. p. 87.
[432] Article, 'University Education in Wales', *The Hospital*, p. 87.
[433] Pauline Adams, 'Penrose, Dame Emily' in *Oxford Dictionary of National Biography* (2004), https://doi.org/10.1093/ref:odnb/35466 [accessed 8 February 2019].
[434] Adams. Penrose also served on the 1919 Royal Commission on the Universities of Oxford and Cambridge.
[435] H. J. W., Hetherington, 'Jones, Sir Henry (1852-1922)', in *Oxford Dictionary of National Biography*, www.oxforddnb.com/view/article/33643 [accessed 7 December 2017]. Gareth Elwyn Jones, 'Edwards, Sir Owen Morgan (1858-1920)', in *Oxford Dictionary of National Biography,* www.oxforddnb.com/view/article/33643 [accessed 7 December 2017].

higher education, with his references to the Welsh university's potential being documented in the commission's report and his speeches.[436] The decision to appointment a man of Haldane's abilities to chair the commission was fortunate for those involved in making plans for a University College of Swansea. Haldane was a practical as well as a visionary reformer and moderniser of higher education, as illustrated by his involvement and support for the separation of the University College of Liverpool from the Victoria University in 1902.[437]

The Commission's committee of five academics, three civil servants, analysed oral evidence from 156 witnesses and gathered information from numerous informal visits to the University Colleges and Cardiff and Swansea Technical Colleges.[438] Haldane clearly understood the importance of personal contact, and viewed the visits or the 'Welsh Expedition' as important as the formal sessions and essential to the credibility of the commission's report.[439] The commission's investigation produced a written account, which became known as the Haldane Report.[440] One of the many claims put before the 1916 commission revealed the inconsistencies of science education at the University of Wales. The College of Aberystwyth's claim that from 1906 the college's departments (including the Faculty of Science), were pursuing a policy of co-ordinated research to address the problems of the region was ambiguous.[441] Sanderson suggests that as there is no evidence of such research in Aberystwyth's own reports from this period, then the claim was either a reference to agriculture research or was an exaggeration to preserve the reputation of the college before the commission.[442]

The commission recognised that the colleges' lack of success in developing connections between their science departments and industry was partly due to the university's desire for compromise and uniformity.[443] The commission observed that:

> In South Wales, especially, it is alleged that this pressure towards uniformity and compromise among institutions remote from one another and in areas with widely differing conditions, works with other causes to excite suspicions which exercise an unfortunate influence on the

[436] Ashby and Anderson, pp. 125-7.
[437] H. C. G., Matthew, 'Viscount Richard Haldane (1856-1928)', in *Oxford Dictionary of National Biography*, www.oxforddnb.com/view/article/33643 [accessed 14 October 2017].
[438] Special Collections and Archives, Ref no: FWG12. U, p. 87.
[439] Ashby and Anderson, p. 125.
[440] Special Collections and Archives, Ref no: FWG12. U, p. 87.
[441] Sanderson, *The Universities and British Industry*, pp. 131.
[442] Sanderson, *The Universities and British Industry*, pp. 131-2.
[443] RBA, 665 / 4, *Royal Commission on University Education*, p. 27.

> relations between the University College and the great industrial community it has to serve.[444]

Yet nearly a quarter of a century earlier, an observation given by Henry Jones at the closing ceremony of the session 1894-95 at Bangor College suggested an independence of choice between the university colleges.[445] Jones stated that the freedoms established within the internal bureaucracy of the university would allow its constituent colleges to determine local educational needs and act on them.[446]

However, it was evident from the early years of the university's history demonstrates a tendency to omit the applied sciences on the curriculum of the constituent colleges. This is illustrated by the university's decision in 1896 to include zoology in the science faculty at all three colleges, yet hesitated from introducing engineering in any of the colleges.[447] A decision which was made by the university with apparent little regard for the educational requirements of industries in South Wales, or the fact that there was a demand nationally for graduates of practical science disciplines.[448] In effect, by applying a central academic policy to the three colleges to ensure the federal system worked efficiently, the University failed to take into consideration certain regional industrial expectations of the individual colleges.[449]

Consequently, the demand for scientists and scientific research which was stimulated by the needs of war encouraged universities to plan for post-war opportunities, thereby prompting discussions within the British academic community of the importance of establishing the PhD degree. This proposed development in higher education was believed to be a constructive way of attracting overseas researchers to Britain, who would have otherwise undertaken their research in Germany before the war.[450] These aspirations were confirmed at a meeting on 10 May 1918 of a Standing Committee, consisting of Vice-Chancellors or Principles of each university and the Executive Committee of the Universities Bureau. The seminal meeting became known as the 'Standing Conference,' and its relevance to the development of academic

[444] RBA, 665 / 4, *Royal Commission on University Education*, p. 27.
[445] Swansea University Library Pamphlets, reference code: W/ LF 1157 – 1220, no., W/ LF 1178.5, Henry Jones, *An Address on 'The Higher Learning in its bearing upon Nation Life in Wales'* (Bangor: Jarvis & Foster, 1895), p. 9.
[446] Jones, p. 9.
[447] Thomas, p. 37.
[448] Thomas, p. 37.
[449] Royal Commission on University Education in Wales (1918), p. 27.
[450] Ashby, pp. 17-22.

research is noted by the physicist Ernest Rutherford (1871-1937) at the conference, who stated:

> An entire innovation. It will involve a full period of post-graduate training, introducing into Britain, a system practically identical with that which obtains in America…. It will be a real and very great departure in English education, the greatest revolution, in my opinion, of modern times.[451]

The complexity of the debates both nationally and internationally around the creation of postgraduate research are carefully examined in Renate Simpson's research, '*How the PhD came to Britain*'.[452] Unlike many histories of education Simpson highlights and discusses progressions made in education in Wales, in this case the determination of the University of Wales to establish an advanced degree in research.[453] Simpson states that by 1900 the format and supervisory structure for a MA by research was established at the Welsh university, which was a pioneering development taken before any other British university including the University of London.[454]

The increased standing of academic research is reflected in the fact that there was a determined political will to establish a PhD degree in British universities.[455] The influence and involvement of high-profile politicians such as A. J. Balfour (1848-1930) and H.A.L. Fisher (1865-1940) who had been appointed president of the Board of Education at the end of 1916, in academic research issues also reflected that political will.[456] Fisher's previous appointment as the Vice-Chancellor of the University of Sheffield gave him a rare insight of the ambitions and needs of the university institution, and his expertise was noted by many who congratulated him on his appointment in David Lloyd-George's new cabinet. In addition, Fisher had been pro-active in establishing academic links and cultural co-operation between Britain and France during 1916.[457] On the other allied front, Balfour as foreign secretary had looked beyond the war and understood the necessity to establish firm Anglo-American academic connections. Balfour believed that an enhanced research programme and the institution of a PhD degree would strengthen Anglo-American academic relations, and therefore

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451 Ashby, p. 22
452 Simpson. For further reading on the international dimension of establishing the PhD degree see: Tomás Irish, *The University at War, 1914-25* (London: Palgrave Macmillan, 2015).
453 Simpson, pp. 98-9.
454 Simpson, p. 99.
455 Ashby, pp. 18-20.
456 Ashby, pp. 18-20. Irish, pp. 56-57.
457 Irish, pp. 88-89.

would tempt American researchers to travel to Britain instead of Germany after the war.[458] Pre-1914 both British and French universities were at a disadvantage in attracting research students due to the exclusivity of the PhD award at German institutions.[459]

The PhD was a symbol of international development in the area of research, as Simpson succinctly concludes – ‘conceived and nurtured in Germany, imported and commercialized by America and finally introduced into Britain’.[460] In fact, educational and intellectual international networks were a part of the immense efforts to secure post-war co-operation between nations. This made the international accomplishments of the Standing Committee an essential element of the committee’s work.[461] However, the standing conference was preceded by a meeting in the Foreign Office, which would have implications for university independence in Britain.[462] Those in attendance included the Chancellor of the Exchequer, the Foreign Secretary, the President of the Board of Education and his counterparts for Scotland and Ireland and deputations from all universities, who met to discuss post-war co-operation with each other and with institutions overseas. There was an acknowledgement that due to the growing national role of the university individual institutional identity had to be protected.[463]

This important issue of whether universities worked as individual institutions or as a collective was discussed at the conference, as well as the other domestic issue of how independent university development was devolved from the State.[464] However, the Board of Education still pressed an earlier claim for authority over university administration as well as further Treasury funding, the Treasury insisted that a new national body that would engage with universities should be formed.[465] To address such problems the government established a new agency, the University Grants Committee, immediately after the war in 1919.[466] The committee’s remit also included the

[458] Ashby, pp.18-20. Balfour’s political career included a term of prime minister between 1902-1905, and his term as foreign secretary in Lloyd-George’s government lasted from 1916-1919.
[459] Irish, p. 101.
[460] Simpson, p. 159.
[461] Keith Vernon, ‘‘We Alone are Passive’. The Committee of Vice-chancellors and Principals and the organisation of British universities, c.1918-1939.’’ *History of Education*, 43 (2014), 187-207 (pp. 10-17).
[462] Ashby, pp. 20-21.
[463] Vernon, pp. 10-17.
[464] Ashby, pp. 20-21.
[465] Vernon, p. 10.
[466] Notker Hammerstein, ‘Epilogue Universities and War in the Twentieth Century’, in *A History of the University in Europe volume III*, ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004), 637-672), pp. 646-47.

promotion of universities and the improvement of their facilities. Hammerstein suggests that the committee had no lasting influence on the conditions at universities, as it was not able to shape their curriculum nor influence the direction of university studies and training.[467] Yet, the committee did act as a mediator between individual universities and the state. This helped ensure the preservation of institutional independence, as the committee negated the need for any direct connection between the universities and the state.[468] However it must be noted that as an agency of the state, the committee was subject to being affected by changes to government policy.[469]

Consolidation of support for the University College of Swansea

The recommendations of the 1916 Royal Commission enabled plans to proceed to establish a fourth constituent college of the University to be based in Swansea. Historically the provision of scientific education was a serious concern for educationalists and industrialists in Swansea, the details of which are discussed in the previous chapter. However, Swansea's early ambitions to provide a comprehensive range of science and technical education at a university level in the town failed in 1883, when the arbitrators deciding where to site a South Wales College decided on Cardiff over Swansea.[470] The increase in Cardiff's infrastructure underpinned by the Bute trustees' extensions and improvements to the town's docks, and accompanied by a significant rise in the population (with the potential for future students) ensured Cardiff won its case.[471] A decision taken regardless of the Aberdare committee's recognition of the importance of the varied industries in Swansea and its region to the Welsh economy.[472]

It is apparent that the issue of location was an important factor in the discussions regarding the proposed site of the South Wales College, yet the proximity of industry did not appear to be a priority. Many complex issues influenced the direction and success of scientific studies in the Welsh university colleges and an appropriate location was one key factor in the successful development of the institutions. This fundamental issue is noted by Sanderson, who questions the suitability of the location of both the

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[467] Hammerstein, pp. 646-47.
[468] Vernon, pp. 9-10.
[469] Vernon, p. 3.
[470] Emrys D., Evans, *The University of Wales - A Historical Sketch* (Cardiff: University of Wales Press, 1953), p. 78.
[471] Chrimes, pp. 17-18.
[472] Chrimes, pp. 17-18.

colleges of Aberystwyth and Bangor, and the decision to establish the colleges away from any areas of industry.[473] If industrial needs had been taken into consideration for a college for North Wales, then the University College, Bangor would have been sited further east along the coastline.[474] An early opportunity for the Welsh University to establish a third college with the potential to create close ties with Welsh industrial and mining industries was lost in 1882 when Swansea failed in its bid. However, the decisions behind determining the site of the Welsh colleges were very different to the narratives behind the location of English civic universities.[475]

The idea of the Welsh University and its Colleges was formed and developed before any towns had been named as their location, which was different to the siting of Owens College in Manchester which set a pattern for English civic universities. The intrinsic reasoning behind the sites of these colleges is explained by an original description of the early established civic universities, which states:

> Each college forms an integral part of a great commercial and industrial community, to whose needs it must ever respond, on whose support its future must eventually depend.[476]

Owens College was situated in the city which desired university education and wished for university research for its industrial community. In this respect the University College of Swansea is the only one of the Welsh Colleges that came close to the civic model in relation to the choice of its location. Indeed, Swansea's proximity to the South Wales College at Cardiff, and the town's relatively small size questions whether the Swansea institution would have existed had it not been for the federal system. [477]

Regardless of Swansea's earlier failure to establish a university college, there was a concerted effort to address the lack of technical and scientific education. Evening technical classes in some of the pure and applied sciences were established in conjunction with the Swansea Grammar School. The technical classes developed in the range of disciplines offered, and by 1900 students were attending day classes in physics, mathematics, chemistry, metallurgy and engineering.[478] Furthermore, temporary laboratories had been built for the chemistry and metallurgy classes, and which also offered practical support for other science modules on the syllabus. The laboratories

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[473] Sanderson, *The Universities and British Industry*, pp. 123-24
[474] Sanderson, *The Universities and British Industry*, pp. 123-24.
[475] University Commission, *Final Reports* (Cardiff: University of Wales Press, 1964), pp. 66-69.
[476] University Commission, *Final Reports*, p. 68.
[477] University Commission, *Final Reports*, p. 68.
[478] Drew, p. 340.

were built on site, and were split to accommodate 'junior' students and 'Honours students.[479] The 'junior lab' accommodated 30 students and the 'Honours' chemical laboratory had room for 16 students.[480] By 1901 the classes became the core element of a Technical College, and after acquiring its independence from the school the college was financially supported by the local education authority.[481]

This transition from school to technical college in Swansea was an educational development which had its origins in eighteenth-century Europe. [482] During the second half of the eighteenth-century the development of technical colleges which focused on training for technicians and engineers, and who had their origins in secondary schools, was a crucial development in German and continental European higher education.[483] There was often financial assistance for students studying at Technical Colleges, as was the case with the Swansea college with scholarships offered in the form of free studentships for artisans and their children.[484] Financial support for the Technical College was still forthcoming from the Swansea Educational Authority over a decade later, as noted at a meeting in April 1915 of the South Wales Institute of Engineers.[485] The minutes of this meeting illustrate the increasing importance that manufacturers were attaching to the provision of education in metallurgical subjects, especially in relation to addressing the growing complexity of technical and scientific problems of tin-plate rolling.[486]

The analysis of the Institute's minutes reveal commitment by the local authority to financially support the provision of technical and scientific higher education in the region. Alderman Ivor Gwynne (1867-1934) who was chairman of the Swansea Technical Education Committee informed the institute's meeting that a future expenditure of between £30,000 to £40,000 was proposed to support the college.[487] However, Gwynne advised caution against unconditional funding of the college,

[479] Swansea Museum Library, Box no: 86, reference no. 78 / 14, *Technical Instruction Committee* (1898) pp. 6-7A.
[480] SML, 86, 78/ 14, pp. 6-7A.
[481] Evans, p. 78.
[482] Charles E., McClelland, *Berlin, The Mother of all Research Universities 1860-1918* (London: Lexington Books, 2017), p. 85.
[483] McClelland, p. 85.
[484] SML, 86, 78 / 14, pp. 6-7A.
[485] Warwick, Modern Records Centre, reference no. MSS.36 / T19 /3, South Wales Institute of Engineers, Swansea, 1915, p. 11.
[486] MRC, MSS.36 / T19 /3, pp. 11, 40. For further reading on the development of the tinplate industry see: Walter Edward Minchinton, *The British Tinplate Industry, a History* (Oxford: Clarendon Press, 1957).
[487] MRC, MSS.36 / T19 / 3, p. 11.

suggesting that to fund the institution without curriculum suggestions from local industry would represent a waste of money. As Gwynne stressed that the college was to offer a technical education which would assist not only the industries of Swansea, but which could benefit the wider region as well.[488]

Gwynne's comments reflected what the local authority expected of any scientific higher education provided locally. A statement given in the Proofs of evidence for a university college in Swansea given to the Royal Commission by Ivor Gwynne declared:

> That the interests of industries which are essential to the prosperity of the community, and the national welfare receive due recognition and the attention which they merit in the work and policy of the university.[489]

How relevant discussions at formal industrial meetings between industrialists and local government officials were, and whether such discussions influenced future educational policy is difficult to assess. However, working relationships did develop between men whose influence extended across both the industrial world and the political world, and who used their connections to further educational progress. In Swansea this type of connection developed between Ivor Gwynne and David Matthews (1868-1960).[490] Gwynne had a long- standing involvement with both the Tin and Sheet Millmen's Association and the Swansea Council as a Labour councillor, while Matthews was a tinplate manufacturer and a Liberal councillor. Both men believed in the development of higher scientific and technical education in Swansea and worked together to extend the involvement of local industrialists with the provision of scientific education.[491]

Corporate support for a university college in Swansea was formally noted in the evidence given to the Royal Commission.[492] Industrialists such as Sir Alfred Mond (1868-1930), Thomas J. Williams (1872-1919), and Charles Hamilton Eden (died 1921), stressed the need for scientific and technical education at university level in the locality.[493] Mond and Williams were also politically involved in the area and served as members of parliament for different constituencies in the Swansea region. As managing

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488 MRC, MSS.36 / T19 / 3, p. 11.
489 RBA / 666, *Proofs of Evidence,* p. 22.
490 Dykes, pp. 64-65.
491 Dykes, pp. 64-65.
492 RBA / 666, *Proofs of Evidence,* pp. 8-15.
493 J. Graham Jones, 'Sir Alfred Mond (Lord Melchett), 1868-1930' in *Liberal History* (2015) https://liberalhistory.org.uk [accessed 11 February 2019].

director of Swansea's oldest industrial firms Messrs Vivian & Sons (established in 1810), Eden confirmed that:

> My firm are strongly in favour of the co-ordination of technical education with the industries of the district and are of the opinion that it is only by the continuous flow of students highly trained in the technology of the various subjects that the several industries which are carried by my firm and others in the district can be adequately developed and fostered.[494]

Eden's belief in industrial progress through formal scientific education was echoed by Williams, who was an MP for Swansea East and whose family had been involved in the Tinplate Industry for three generations. Williams believed that the industry's practise of promoting workers through seniority rather than scientific qualification hindered industrial development, thereby indicating that there was a need for scientific research in the different branches of the tinplate industry. The Swansea M.P.'s conviction that a university college in Swansea would be of great benefit to all in the industries in Swansea and the south-western region of Wales was also shared by Mond.[495]

Mond, an influential industrialist had a deep understanding of the necessity of developing connections between science and industry, as the foundations of the Mond Nickel company had depended on such a relationship.[496] The discovery of a previously unknown compound nickel carbonyl (a gas formed from carbon monoxide and metallic nickel) by Mond's father, Dr Ludwig Mond (1839-1909) was a technological advancement that allowed the industrial extraction of nickel from its ores.[497] Mond established nickel and copper mining and smelting businesses in Ontario, Canada, and had the nickel refined by his patented process known as the 'Mond process' at Clydach, Swansea.[498] The 33 acre refining works which were established in 1902 became part of an established industrial hinterland of Swansea, and while both of Mond's sons Robert and Alfred were involved in the industry, it was Alfred Mond who became involved in the political and cultural life of Swansea.[499] By his involvement in the campaign to establish scientific higher education at Swansea, Mond was following his father's

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[494] RBA / 666, *Proofs of Evidence*, p. 15.
[495] RBA / 666, *Proofs of Evidence*, pp. 8-14.
[496] Grace's Guide to British Industrial History, *Mond Nickel Co (*1947). https://www.gracesguide.co.uk/Mond_Nickel_Co [accessed 11 February 2019].
[497] Frank Greenaway, 'Mond Family (per. 1867-1973)', in *Oxford Dictionary of National Biography* (2011), https://doi.org/10.1093/ref:odnb/51124 [accessed 12 February 2019].
[498] Grace's Guide, *Mond Nickel Co.*
[499] Greenaway.

assertion that scientific education should be centred on pure science and not just on its profitable application.[500]

The impetus to further scientific education and research which would meet the needs of industry in South Wales, officially gained momentum at a special meeting of the Swansea Education Committee on Wednesday 27 July 1917.[501] The meeting was specifically called to discuss the basis of a draft Charter of the proposed University College, Swansea.[502] This assembly was the inevitable result of negotiations undertaken between 1903 and 1906 between Swansea Town Council and the University Court.[503] The discussions focused on Swansea Town Council's ambitions for the local Technical College to be recognised as an affiliated College of the University.[504] It is understandably that there were such ambitions for the Technical College, as the institution had been the focus of higher educational developments in Swansea since the town had failed in its bid to site the South Wales College of the University of Wales. An added incentive to develop the Technical College at Swansea towards university status, was that this type of educational development of Technical Colleges was becoming increasingly common in England and Scotland.[505] Dr W. Mansergh Varley, principle of the Swansea Technical College cited examples of technical colleges that had become universities, or had become affiliated to a university in his evidence to the Royal Commission.[506] Such institutions included Manchester School of Technology, Sheffield Technical Institute, The Merchant Venturers' Technical College at Bristol, the Edinburgh Heriot-Watt College and the Royal Technical College at Glasgow, all of which had the power to grant internal degrees.[507]

Even as late as 1920 the development and educational upgrading of the Technical College was still the focus of the local authorities in providing science higher education in Swansea, with the local authorities officially confirming its support at a meeting on 20 January 1920.[508] There was great enthusiasm for the Technical College to be the

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500 Greenaway.
501 Richard Burton Archives, Swansea University Library, Box number 583, (uncatalogued bundle 1 of 2), *Swansea Education Committee Minutes* [extracts of] (1916-17).
502 RBA, 583 / 1 / 213 / 1, *Swansea Education Committee Minutes.*
503 Ellis, p. 140.
504 Ellis, p. 140.
505 RBA / 666, *Proofs of Evidence*, p. 34.
506 RBA / 666, *Proofs of Evidence*, p. 30.
507 RBA / 666, *Proofs of Evidence*, p. 30.
508 Richard Burton Archives, Swansea University Library, Box no. 664, *Swansea Education Committee* (20 January 1920), p. 280.

nucleus of the new university college from local organisations such as the Swansea and District Labour Association, the Llanelli and District Labour Association, Swansea and District Co-operative Society and the Western Miners Federation.[509] While the original petition for a Royal charter for a University College, Swansea was formulated around the provision of Pure and Applied science and technical education, the education committee's resolution was a firm commitment to the provision of the Arts subjects as well. To a certain degree the council authorities had no option but to include an Arts Faculty as the commission had made it very clear that was what they expected, with the commissioner's report stating 'pending the establishment of a complete Faculty of Arts provision must be made for Higher Education in subjects belonging to that Faculty'.[510] The commission wanted clarity that the proposed university college would implement both a science and an art faculty, and to that end Lord Haldane and Sir Henry Jones thoroughly cross-examined the Swansea witnesses.[511]

One pioneering voice supporting a Faculty of Arts was the industrialist Francis William Gilbertson (1873-1929) who would play a key role in defining the structure of the university college as its president during its formative first decade.[512] Gilbertson had come to the conclusion that the humanities and the sciences would have to have an equal place in the new institution, stating the earlier adage that the 'whole man will be seen to, not a part'.[513] There is a high probability that the revised plans for the academic structure for the university college had a bearing on the decision to establish a completely new higher education institution. However, there are very few primary sources which document the discussions that led to the fundamental change of direction of the proposed university college. What is clear is that there was an immediate problem in finding appropriate accommodation for both faculties, a problem that would continue with the long-term development of the institution.[514] Provision for the college was offered over three sites, at the Technical College at Mount Pleasant, the Swansea Training College (established in 1913) at Town Hill and the Swansea School of Art in Alexander Road, all of which had limited space for academic expansion or the creation of recreation or sport facilities. However, in 1920 a prime piece of real estate, the 250

[509] RBA / 664, *Swansea Education Committee*, p. 169.
[510] RBA / 664, *Swansea Education Committee* (23 January 1919), p. 2.
[511] RBA / 664, *Swansea Education Committee*, p. 2.
[512] RBA / 664, *The Institute of Metals. Souvenir Swansea Autumn Meeting* (1922), p. 17.
[513] RBA / 664, *The Institute of Metals*, p. 17.
[514] Dykes, pp. 78-9.

acre Singleton estate in Swansea was bought by the local corporation, and the sale cemented the future for the University College of Swansea and its campus.[515]

Conclusion

The early-twentieth century national concerns of the disengagement between academia and industry were mirrored in the regional concerns in Wales. From the evidence presented to the 1916 Royal Commission it is evident that University of Wales was successful in establishing science faculties at the three constituent colleges at Aberystwyth, Bangor, and Cardiff. Furthermore, the Biology and Agriculture departments at the colleges of Aberystwyth and Bangor pioneered successful connections with traditional fishing and farming communities, which tailored research projects to their industries' specific needs. Yet, the University of Wales response to the regional higher educational needs of an increasing industrialized Wales were perfunctory and were compounded by a cultural bias towards the humanities. A predicament which helped create conformity and uniformity within the university's federal system and guided the university colleges away from using the flexibility of the institution's system in relation to their individual curriculum policies. The consequence of this uniformity was a failure by the three university colleges to establish successful teaching and research programmes that connected with the vital industries of Wales. This educational omission was in part due to the rural location of two of the colleges, but in all these cases there was the problematic stance taken by a section of the industrial community. The viewpoint that the Welsh colleges were not failing to provide scientific education, but whether the education they offered had any consequences for Welsh industry negatively shaped academic and industrial relations.

However, it was the outbreak of World War I and the years of conflict that focused political, industrial, and educational conversations on the inadequacies of scientific university education and highlighted the vital role of university scientific research. Also, the wartime demands for the products of the steel, tinplate and chemical industries revealed deficiencies in the capabilities of production. As the conflict progressed these difficulties were the catalyst for government departments, science departments and industry to actively engage in collaborative research projects that supported the war effort. Additionally, the skills shortage that was required to meet the increasingly

[515] Dykes, p. 79.

complex industrial and military needs of the conflict was temporarily resolved by scientists and technicians from universities across the British colonies. A positive outcome from the urgency of wartime demands was that academic connections between institutions in Britain as well as transnational academic ties were strengthened. Furthermore, the combination of industrial failings, problematic provision of scientific research and the increasing volume of the public science debate led to the establishment of the DSIR. The creation of this government department was an important step towards addressing the confusion of state funding for research and financial support for research students, as well as consolidating industrial and academic ties.

Post-World War I the identity of the university as an institution was challenged and science was at the core of the discussions. Vital collaborations that were created during the conflict between academic science departments, industry, and government agencies such as the military, highlighted the relevance of academic science. It was recognised that the university as an institution had a vital role to play in the expansion of scientific research in Britain. However, concerns regarding the authority of the Treasury countering the independence of academic institutional communities led to tensions over state aid, which were eased by the establishment of the University Grants Committee in 1919. University development was strengthened by the introduction of the PhD which consolidated the research status of science departments, while the extension of educational international connections ensured that academic scientific co-operation was re-established in a post-war world.

In Wales, the inadequacies of scientific university were reflected in The Haldane Report, which had a direct influence on the decision by the University of Wales to establish a fourth constituent college, which was to be sited at Swansea. This decision was a public acknowledgement of the need for a higher education institution which would deliver scientific teaching and research requirements of the industrial region of South Wales. Furthermore, the proofs of evidence to the commission from industrialists and politicians of this region reveal an established network of political and financial support for upgrading the Swansea Technical College to the status of a university. Subsequently, the final decision to create a new institution at Swansea was shaped by the established ‘idea’ of a university which would deliver both a science and arts curriculum.

Chapter Three – A Decade of Development: Construction and Community, 1920 - 1930

Introduction

Chapter Three focuses on the development of the science faculty during the University College of Swansea's first decade between 1920 and 1930. The chapter argues that the successful relocation of the science faculty from the temporary residence at the Swansea Technical School to the university college's permanent site at Singleton Abbey was due not only to the administrative skills and vision of the institution's first principal, the geologist Franklin Sibly, but also on the co-operation and determination of the heads of the different scientific disciplines. The calibre and academic expertise of the scientists who were employed to establish and head these new departments was crucial in consolidating and shaping the direction of the college's science faculty, and their input is critically assessed in this section. The departments of geology, metallurgy, physics, chemistry, and biology were the nucleus of the new science faculty. The chapter contends that the staff of these departments established and developed internal communities within their disciplines and between the other departments which was critical in consolidating an academic scientific community in the newly established institution.

The creation of teaching and research space on the Singleton campus was essential and played a significant part in shaping a sense of community within the disciplines of the science faculty. This section asserts that the construction and fitting out of the temporary science buildings was the single most significant project that symbolised the establishment of not only the science faculty, but also the University College of Swansea. However, the financial pressures of establishing and equipping laboratory space for the different disciplines was a major problem for the new institution. Therefore, the chapter claims that the preservation of early industrial and political connections with the Swansea university movement were paramount during the first decade of the Swansea University College, and explores the methods used by both staff at the university college and industrialists in consolidating these relationships. The cultivation of links outside of academia, especially with industrial organisations, societies, museums, and individual scientists, were vital to the early development of the institution's scientific research community and its research facilities, and these connections are identified and explored.

In addition, the successful integration of the University College of Swansea into the established federal system of the University of Wales is explored in the context of departmental compromise and integration. Thereby, this section assesses the pro-active steps taken by the science departments at the institution in establishing inter-collegiate connections with the other Welsh constituent colleges of Aberystwyth, Bangor, and Cardiff. Finally, while the University college can assert that it continued to be successful in establishing strong links with local industry, the chapter asserts that the relationship with the wider community of Swansea was initially as a service provider for the institution. However, the chapter shows that tentative steps were taken by the university college towards establishing informal educational links with the town of Swansea and its wider region.

A New Beginning – The Establishment of a Science Faculty

The development of the science faculty at the University College, Swansea began in earnest when the institution moved to its permanent site at Singleton Abbey in 1921. Overseeing this complex operation was Frank Sibly (1883-1948) who had been appointed to the position of principal of the University College, Swansea in 1920.[516] Sibly joined the three other principals of the constituent colleges of the University of Wales whose job role not only included the administration of their own colleges, but who consecutively held the post as Vice-Chancellor of the University.[517] The Vice-Chancellor was a senior appointment and the deputy to the Chancellor, the executive head of the university. The governance of the university was represented by court, council, and senate.[518] As the senate composed of the colleges' head of departments it provided the academic expertise on matters such the curriculum which were then formally acted on by the supreme governing body, the University Court.[519] The council was a small executive body that acted as the financial and administrative authority to the

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[516] T. A. B. Corley, 'Sibly, Sir (Thomas) Franklin (1883-1948)', in *Oxford Dictionary of National Biography* (2004), https://doi.org/10.1093/ref:odnb/36082 [accessed 4 March 2018].
J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997), p. 225.
[517] Williams, pp. 5-6.
[518] Swansea University Library Pamphlets, reference no: W/ LF 1140, *Heads of an Act of Charter to constitute the University of Wales* (1893).
[519] Davies and Jones, p. 203.

court.[520] As three of the constituent colleges had been established prior to the creation of the University of Wales they had formed their own collegiate Courts of Governors which had representatives from their financial subscribers and local public bodies. To that effect, the University Court was modelled on this precedent and consequently the overall government of the university was democratic in its representation.[521]

Each constituent college including Swansea had its own governing bodies of court and council under the office of a president and vice-president, with the post of principal as the chief executive and chief academic of the institution.[522] As the institution's first principal, Sibly's approach to the management and development of the university college would define the course of that progression and the character of the institution. Creating an environment that would not only encourage bureaucratic developments, but which would sustain the newly appointed academic staff working within a basic framework needed an individual with a strength of character and the ability to engage. Sibly's previous academic posts influenced and shaped his approach to delivering scientific teaching, which made him suitable for the post. Before accepting the Principalship at Swansea he gained experience of working within two different institutions, a federal college (University College of South Wales and Monmouthshire, Cardiff, University of Wales) and a technological institution (Armstrong College, Newcastle).[523] At these institutions Sibly had acquired a reputation as a successful researcher and lecturer in geology, with his work on carboniferous limestone in the Mendip Hills being regarded as one of the classics of carboniferous stratigraphy.[524]

Sibly began his research on the Mendip Hills just before his appointment to the post of lecturer at King's College, London, working under Professor Govier Seeley (1839-1909). Seeley was a prodigious and influential researcher in Geology, Geography and Minerology who had connections with national and international geologists and palaeontologists across Europe, Africa and India.[525] While Sibly did not work with

[520] Dykes, p. 72.
[521] Davies and Jones, p. 205. Williams, p. 6.
[522] University College of Swansea, *Supplemental Charter and Statutes* (1959), p. 2.
[523] Corley.
[524] Corley. Stratigraphy is a branch of the discipline of geology concerned with the study of rock layers and layering, with carboniferous being a geological period and system spanning 60 million years. The term carboniferous meaning coal-bearing was penned by the British geologists William Conybeare and William Phillips in 1822. https://www.britannica.com
[525] 'Eminent Living Geologists: Professor H. G. Seeley' in *The Geological Magazine*, vol. IV, no. VI (June 1907), pp.241-253, https://www.cambridge.org/core/journals/geological-magazine/issue [accessed 6 March 2018], pp. 241-244.

Seeley for long, there was a high probability that the ethos of practicality and flexibility that Seeley fostered in his teaching methods of encompassing practical field trips and research would have influenced the young geologist. In addition, the ability to work within different spheres of scientific learning and areas of research was another accomplishment which Seeley mastered, combining working within academia and engaging with museums across Europe and Russia. An example of Seeley's ability to be flexible and combine his different areas of expertise is evident in his role as a palaeontologist. This activity illustrated his success as a field researcher which produced significant finds of fossilised reptile skeletons at his excavations in the Karroo Beds of South Africa, and his skill at preserving and exhibiting the finds at the British Museum.[526]

Sibly recognised that a flexible approach was essential to managing the young institution through its difficult early years. Contemporary sources acknowledged that the Principal's approach to the managerial aspect of his role was also accompanied by an ethos of accessibility towards his members of staff. A further advantage of working with such a prominent scientist as Seeley was the opportunity of interacting with his academic networks. The appointment at King's College bought Sibly into contact with many contemporary leading geologists, connections which he cultivated and who remained his colleagues and friends.[527] Establishing contacts within specialised disciplines and the wider scientific community were important to building networks between higher educational institutions. Furthermore, due to its remit it was essential that the University College, Swansea build contacts with the local industrial community. The ability to initiate and foster connections was one of Sibly's strengths, and this skill is evident from his time at University College, Cardiff and Armstrong College, Newcastle, where his reputation as an academic administrator was established.[528]

Haldane was aware of Sibly's skills as an ambitious and visionary academic administrator and gave his full support to the appointment of Sibly as the institution's first principal.[529] The statesman had been particularly impressed with the academic's evidence given to the Royal Commission on behalf of the University College, Cardiff's senate and the Business Committee. Haldane's support for the scientist ended any

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[526] Eminent Living Geologists: Professor H. G. Seeley, p. 245.
[527] Corley.
[528] Dykes, p. 82.
[529] Dykes, p. 82.

disagreements between the members of the university college's sub-committee's tasked with finding a principal.[530] Sibly's qualities as an academic statesman were validated when later on in his career he was offered the chair of the executive of the Universities Bureau of the British Empire, which had the distinguished title of being the world's first international university network.[531] Sibly occupied the post from 1929 to 1934, and went on to influence the direction of policies and practice of British universities through the years of World War II in his later appointment, 1938-1943, as chairman of the Committee of Vice-Chancellors and Principals.[532]

In 1919 the same year that the University College, Swansea was granted its charter, the Universities Bureau formally consolidated its aims and objectives.[533] The Bureau which was later known as the Association of Universities of the British Commonwealth strengthened and extended its efforts at mutual co-operation between universities. The organisation's main objective of establishing an office of information for the universities of the Empire with its intention of forming formal and informal exchanges, is an example of a post-war transnational academic network.[534] The interwar era witnessed a surge in the formation of numerous transnational associations of many professional disciplines including the natural sciences.[535] Biology, chemistry, physics, geography and microbiology were just some of the scientific disciplines which formed unions in this period. Interaction between the unions was further strengthened when their central supporter, the International Research Council which was founded in 1919, then became the International Council of Scientific Unions in 1931 basing its headquarters in Paris.[536] Sibly understood the importance of such transnational connections. At his Inaugural address at Swansea University, College in 1920 the Principal's comments on the university's special duties to the people of Wales and especially those in the Swansea region were to be expected.[537] However his comment

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[530] Dykes, p. 82. Dykes goes into further detail regarding the narrative around the appointment of the first principal.
[531] Obituary, (22 April 1948), Sir Franklin Sibly, Administrator and Geologist, *The Times*, p. 7.
[532] Ashby, p. 7.
[533] Ashby, p. 27.
[534] Ashby, pp. 21-7.
[535] Emily S. Rosenberg, 'Transnational Currents in a Shrinking World' in *A World Connecting 1870-1945*, ed. by Emily S. Rosenberg (Cambridge, Massachusetts: The Belknap Press of Harvard University Press, 2012), pp. 931-32.
[536] Rosenberg, p. 932.
[537] Richard Burton Archives, Swansea University, Box no: 583 / 2A, Principle T. Franklin Sibly, *Inaugural Address*, (15 November 1920).

that it was ‘our duty to play our part in the world-mission of the Universities’ gives an insight into the ambitions that the Principal held for the institution.[538]

The concept of a ‘world-mission’ of the university institution tied in with the expansion of the civic or redbrick type of university both in Britain and across the colonies.[539] The global success of the civic/redbrick blueprint was such that it was the model used for the reformed University of Calcutta in 1919.[540] Historically, the ‘mission’ of the university institution has been a set of multi-layered variables which were changeable to the outside pressures of not only educational policies, but of philosophical ideals and the cultures of societies and learned institutions.[541] In his 2006 paper on university missions John C. Scott analyses the historical developments of these institutional missions. Scott notes that there is a central theme running through the six missions he reviews which is ‘service’, a theme which has been of historical importance to the institution. As a social organisation they provided higher educational services such as teaching, as well as ‘a host of other academic services to the church, governments, individuals, public and in the future, perhaps the world’.[542] While it is highly probable that Sibly would have approved of the transnational scope of Scott’s comment, he certainly would have recognised the importance of the concept of service within the description of the mission of the university.[543]

The progressive mission of the new university college demanded that a forward-thinking team was appointed to ensure that the departments at the college achieved their goals. It was equally important that the academics who were appointed to take on the duties as head of department, were prepared to build their departments from scratch. There is an absence of correspondence in the archives which discusses the reasons why the college authorities chose the academics they did for the heads of the science departments. Yet, one item of correspondence from a candidate, G. A. Schott (1868-

[538] RBA, 583 / 2A. For further reading on transnational academic connections in 1920s see: Marie-Eve Chagnon and Tomás Irish, eds, *The Academic World in the Era of the Great War* (London: Palgrave Macmillan, 2018). A. G. Cock, ‘Chauvinism and internationalism in science: the International Research Council, 1919-1926’ *The Royal Society Journal of the History of Science* (1983), 249-288. Brigitte Schroeder-Gudehus, ‘Challenge to Transnational Loyalties: International Scientific Organisations after the First World War’ *Science Studies*, 3 (1973), 93-118.
[539] William Whyte, *Redbrick A Social and Architectural History of Britain’s Civic Universities* (Oxford: Oxford University Press, 2015), pp. 189-90.
[540] Whyte, p. 190.
[541] John C. Scott, ‘The Mission of the University: Medieval to Postmodern Transformations’ *The Journal of Higher Education*, 77 .1 (2006), 1-39, p. 3.
[542] Scott, p. 3.
[543] RBA, 583 / 2A.

1937) who applied for the chair of mathematics illustrates an age bias in the college's selection process of candidates.[544] Schott had been Head of Mathematics for ten years at Aberystwyth University College when he applied for the new post at Swansea.[545] During the candidature process the professor became aware of the university college's explicit preference for candidates under 40 years of age, and withdrew his application.[546] Schott was 52 years of age at the time when he applied for the Swansea position.[547] Whether the university college authorities discussed implementing limitations for candidates such as an age limit is difficult to ascertain, as there is no other reference to an age bias in the university's archives.

However, a candidate's age does seem to have been a consideration for the university college when filling the senior posts of the science departments. This supposition is backed up by the age of the successful candidates who were employed to head the science departments. All the successful candidates were in their thirties with the one exception being Arthur Trueman (1894-1956), who was only aged 26 when he was appointed head of Geology.[548] The strategy of employing younger academics to run the new departments opposed to older academics suggests that the college authorities recognised that more was needed from its new heads of departments than just having an academic reputation. Although academic abilities were not in question when assessing the credentials of department heads like Trueman, Charles Edwards (1882-1960) and Joseph Edward Coates (1883-1973) and Florence Mockeridge (1889-1958).[549] These scientists would play a defining role in shaping the science faculty, and aspects of their involvement will be discussed later in the chapter. What is particularly relevant is how earlier personal connections between members of staff came into play when determining who would be appointed to the science faculty at Swansea. For example,

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[544] Richard Burton Archives, Swansea University, reference no. UNI / SU / AS / 2 / 1 / 3, Schott, *Letter to Principal Sibly* (13 June 1920).
[545] A. W. Conway, *Professor G. A. Schott (1868-1937)* rsbm.royalsocietypublishing.org/content/royobits/2/7/457 [accessed 1 April 2018], p. 451.
[546] RBA, UNI / SU / AS / 2 / 1 / 3, *Letter to Principal Sibly*.
[547] RBA, UNI / SU / AS / 2 / 1 / 3, *Letter to Principal Sibly*.
[548] W. J. Pugh, 'Arthur Elijah Trueman, 1894-1956', *Biographical Memoirs of Fellows of the Royal Society*, 4 (1958), 291-305 http://rsbm.royalsocietypublishing.org [accessed 23 October 2017].
[549] Donald Walter Hopkins, 'Edwards, Charles Alfred (1882-1960), metallurgist and principal of University College of Swansea', *Dictionary of Welsh Biography* (2001), http://yba.llgc.org.uk [accessed 30 April 2018]. National Portrait Gallery, *Joseph Edward Coates (1883-1973), Professor of Chemistry*, https://www.npg.org.uk [accessed 12 March 2019]. H. E. Street, 'Prof. Florence Mockeridge' in *Nature*, http://www.nature.com/articles/183150a0.pdf [accessed 18 June 2018], p. 150.

the impressive academic abilities of Trueman had come to the attention of Sibly when he had been one of Trueman's examiners of his Geology B.Sc. exam in 1914.[550]

The interest in Trueman's abilities would result in a career in academia for the young geologist, when in 1917 Sibly offered him a position on his staff in the Department of Geology at Cardiff University College. Their working relationship continued when Sibly left Cardiff to take up the position of Principal of Swansea University, College in 1920, and Trueman joined him when he was appointed Lecturer and Head of the Department of Geology.[551] In certain ways Trueman's student experience reflected that of Sibly's early career as a geologist, in that he too was influenced by an older innovative academic. Trueman was taught geology by Professor H. H. Swinnerton (1875-1966) at Nottingham University College. During this period Swinnerton was preparing his research for his influential book *Outlines of Palaeontology,* however he took time to support Trueman in his research into the Liassic rocks and fossils of the Nottingham area. This study resulted in a paper being published in 1915, and further papers were published on a Liassic rock succession in South Lincolnshire.[552] It was during his time at Nottingham that Trueman developed the practice of undertaking extensive field research with his theoretical studies, a convention he used throughout his career.[553]

The Metallurgy Department was also formed with professionals who had the benefit of working with each other. The head of the Department of Metallurgy Professor Edwards brought with him to the university college colleagues from his previous appointment. These three colleagues of Edwards accompanied him to Swansea University, College. A. L. Norbury, A. J. Murphy and C. R. Austin.[554] The act of three members of staff leaving a department with their senior colleague must have raised concerns at Manchester University. While the move was considered by some colleagues as an act of loyalty and admiration for Edwards, the dismal working conditions of the Metallurgy Department at Manchester must have come into the equation. At that time the Metallurgy Department was situated in the basement of the Chemistry

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550 Pugh, p. 292.

551 Richard Burton Archives, Swansea University, Box no: 583 / 2A, Uncatalogued bundle 1 of 2, *Swansea Education Committee* (20 January 1920), p. 225.

552 Pugh, p. 295.

553 Pugh, p. 292.

554 L. B. Pfeil, 'Charles Alfred Edwards, 1882-1960' in *Biographical Memoirs of Fellows of the Royal Society,* vol. 6 (1960), 33-38 http://www.jstor.org/stable/769332 [accessed 13 March 2017], p. 34. After leaving Swansea A. L. Norbury would have a career in Metallurgy becoming Director of the departments of Physical and Industrial Metallurgy and in 1955, Principal of the College of Aeronautics, Cranfield.

Department.[555] During his time at Manchester University Edwards would have had formal and informal connections with senior members of staff from the other science disciplines of the faculty. Edwards would have met or known of the senior lecturer of the physics department at Manchester Dr Evan Jenkin Evans (1882–1944).[556] Evans worked at the Victoria University at Manchester from 1908 and was offered the post of senior lecturer at the Physics department in 1915 and went on to become the assistant director of its physics laboratories. In 1920 Edwards and Evans became colleagues in the science faculty at the Swansea University College, Swansea, when Evans was appointed head of the Physics department at the newly established institution.[557]

The final head of department of the science faculty to be appointed was Florence Mockeridge (1889-1958) who took up her position in 1922, and unlike her colleagues had no previous connections with other senior staff of the Swansea institution.[558] The only female senior staff member of the science faculty, Mockeridge's previous posts had been as demonstrator and then lecturer at King's College, London where her research studies had received awards which included the Carter Gold Medal of King's College and research grants from the Board of Agriculture and Fisheries.[559] Mockeridge's appointment was made at a later date than the other departmental heads of the science departments, as it was only at the end of the first academic year that there were discussions on the possibility of adding the disciplines of Botany and Zoology to the science faculty.[560] These discussions led to a decision by the college authorities to establish a Department of Biology and appoint a lecturer in Biology who would also have the responsibility as head of department.[561] Whether Mockeridge was fully aware of the workload that awaited her is a difficult question, but in a letter to the registrar, Edwin Drew, she does inquire whether she would be responsible for setting up the department and whether there were sufficient funds to equip the proposed department.[562]

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[555] Pfiel, p. 34.
[556] Edwin Augustine Owen, 'Evans, Evan Jenkin (1882-1944), Physicist and University Professor', in *Dictionary of Welsh Biography* (2001), http://yba.llgc.org.uk [accessed 18 January 2018].
[557] Owen.
[558] H. E. Street, 'Prof. Florence A. Mockeridge' *Nature*, 83 (1959), 150.
[559] Street, p. 150.
[560] Richard Burton Archives, reference no: UNI / SU / AS / 4 / 1 / 1 / 1, Senate Minutes 1920-21, *Minutes 1921*, p. 1.
[561] RBA, UNI / SU / AS / 2 / 1 / 27, University College of Swansea, *New Departments* (1921).
[562] RBA, UNI / SU / AS / 2 / 1 /29A, Florence Mockeridge, *Letter to the Registrar E. Drew* (1922).

The concerns of Mockeridge's and the other newly appointed members of staff went initially through the office of the registrar. The registrar's role in heading the institution's clerical staff and serving as a secretary to the council, the senate and their numerous committees made it a key position in the bureaucracy of the university college.[563] The appointment of Drew as registrar was an asset to the Swansea institution, as he had gained experience from his previous post as the chief clerk and finance clerk at the University College of Cardiff and he had an aptitude for administrative work. Drew's skills were particularly needed by Sibly during the institution's difficult early years.[564] The extent of those early difficulties was summed up by Mockeridge in 1954 during a reflection of her career at the institution, stating that 'our college' was a community of 35 staff 'co-operating in the fight for its life under very difficult conditions of finance and of restriction of space'.[565]

Constructing Teaching Space and Research Laboratories

The plans to move the University College, Swansea from its temporary housing at the Mount Pleasant campus of the Technical College to a permanent site at Singleton Abbey were not without political controversy.[566] In his history of the institution, David Dykes confirms the political element around the institution's move was mostly connected to the local authority's financial policies.[567] However, regardless of financial pressures, the university college's move to Singleton Abbey and the construction of new science buildings were imperative to the cohesion of the new institution. During its first year the new university college depended on the Technical College at Mount Pleasant to host the science departments, which enabled the science faculty members of staff to have access to the college's laboratories. This temporary arrangement was not without its problems. The science departments of the fledgling university college had to function within severe restrictions of space and equipment during its time at the Technical College.[568] Further accommodation was provided in Brynsifi House for the Geology department, but the conditions were no better than at Mount Pleasant.[569] This

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[563] Dykes, p. 84.
[564] Dykes, p. 84.
[565] RBA, reference no: Box no. 664, Professor F. A. Mockeridge, 'Retrospect' in *Dawn* (1954), pp. 4-5.
[566] Dykes, pp. 93-96.
[567] Dykes, pp. 93-96.
[568] West Glamorgan Archives, reference no: D/D UCS 1/1, University College of Swansea, *First Report to the Court of Governors* (1920), pp. 5-7.
[569] Dykes, p. 93.

was due to the space made available to the Geology department was also being used as an electrical research laboratory for the Physics department.[570] A further disadvantage of using the college laboratories was that laboratory equipment was limited and inadequate for teaching and conducting research at a university level. The laboratories had been fitted mainly for the requirements of evening class students.[571]

These practical matters occupied the council of the university college during the institution's first year to such an extent that the seriousness of the situation was stressed in the council's first report to the governing body.[572] While, there is very little primary source evidence which sheds light on the tensions felt by both university and college staff created by working in such cramped conditions, a glimpse into the difficulties and pressures which were felt by scientific staff are revealed in a letter written in 1925 by the head of Engineering Professor Frederick Bacon (1880-1943).[573] Due to financial constraints and delays in finishing the allocated space for engineering at the Singleton campus the department had failed to vacate the Technical College five years after the department's establishment. Further delays prompted a frustrated Bacon to write to both the registrar Edwin Drew and the architect warning them of the consequences of failing to act, he stated:

> Mr. (Gilbert) Jones has made himself unpleasant already and if I am not clear away before Monday September 7th he is most certainly going to be vindictive and I believe he can make quite a good case for his committee that our College is obstructing him from carrying out their instruction.[574]

The relevance of Bacon's letter is clear, as the correspondence illustrates how having to sharing limited departmental space with another institution generated disorganization and put immense pressure on all the staff involved.[575]

The practical pressures of the university college staff were an addition to the difficulties of establishing new departments. So, it was a relief for both the university staff as well as the Technical College staff when the chemistry and metallurgy departments moved to the Singleton Abbey site. The Singleton site and its surrounding parkland was acknowledged as being a prime location in Swansea. This sentiment was

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[570] Richard Burton Archives, Swansea University, reference no: UNI / SU / AS / 2 / 1 / 37, Director of Education, *Letter to Registrar E. Drew* (27 July 1922).
[571] Dykes, pp. 92-93.
[572] WGA, reference no: D/D UCS 1/1, pp. 5-7.
[573] RBA, UNI / SU / AS / 2 / 1 / 65.
[574] RBA, UNI / SU / AS / 2 / 1 / 65.
[575] RBA, UNI / SU / AS / 2 / 1 / 65.

re-enforced in 1925 when the President of the Institution of Civil Engineers (ICE), Sir William Ellis (1860-1945) remarked on the quality of the site, observing:

> When at Singleton it is difficult to conceive one is really in the centre of one of the most important steel manufacturing centres not only in South Wales, but in the country generally! – because of the lovely location of college.[576]

However, what is apparent from university records is that the process of completing the construction of the temporary science buildings at the Singleton site was not without problems. Initially, the indecision of the Corporation regarding the long-term plans for the entire Singleton Estate created an atmosphere of uncertainty over the permanency of the site allocated for the university college.[577]

Amid this uncertainty were further concerns over the estimated cost of the temporary science buildings, which the Corporation considered was high and an unnecessary expenditure as the buildings were considered temporary.[578] From the Corporation's viewpoint their feeling of disquiet over further financial obligations to the university was justified.[579] The Corporation believed that they had given sufficient financial support to the university college by upgrading the Abbey building, therefore they were wary about committing themselves to further financial aid.[580] The whole of the north wing of Singleton Abbey had been destroyed by fire in February 1896 and the remaining part of the building fell into a state of disrepair, thereby requiring substantial structural alteration and updating before it was suitable to be used as an educational institution.[581] The renovation work in the Abbey was completed before the university's second session.[582] However, support for the Corporation's viewpoint came from the Parliamentary and General Purposes Committee who also believed that the proposed expenditure of £48,000 was excessive.[583]

The Corporation finally agreed to fund the construction of the science buildings, on the condition that the university council pay for the services of the borough architect

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[576] Garth Watson, *The Civils* (London: Thomas Telford Ltd., 1988), p. 252. Swansea Museum Library, Box no: 86, reference no. 78 / 24, *Swansea University College Engineering Society, vol. 1,* (1925).
[577] Richard Burton Archives, reference no: UNI / SU / ACM / 3 / 2 / 1 / 4, *Buildings Committee* (22 April 1921), pp. 51 and 66.
[578] RBA, UNI / SU / ACM / 3 / 2 / 1 / 4, p. 51.
[579] RBA, UNI / SU / ACM / 3 / 2 / 1 / 4, p. 51.
[580] RBA, UNI / SU / ACM / 3 / 2 / 1 / 4, p.51.
[581] Geraint H. Jenkins, The University of Wales. An Illustrated History (Cardiff: University of Wales Press, 1993), p. 122.
[582] Dykes, p. 96.
[583] RBA, UNI / SU / ACM / 3 / 2 / 1 / 4, p. 40.

and his staff.[584] However, the funding for the science buildings was in the form of a forty-year loan, which was finally written off as an endowment to the college in 1923.[585] In effect this was a symbolic payment from the university college. In contrast to the renovation work on the Abbey building the completion of the temporary buildings took longer. While the accommodation for the departments of metallurgy and physics became available for use by the college's second session, the Chemistry department was only able to move in during the latter part of 1923.[586] There had been delays with the chemistry building and concerns were raised by the University Council early in 1922 that the building would not be ready for the following session in October.[587] Unfortunately, even an intervention by Ernest Morgan, the architect, to hurry the works failed to ensure that the building was ready on time.[588]

As temporary buildings there was little attention given to their outward appearance, a fact noticed by Leonard Wright who referred to the buildings as 'huts'.[589] Wright, who was employed as an assistant lecturer in Physics, suggested they resembled the type of buildings he had occupied while in the Army and Air Force.[590] While the accommodation and laboratories of the science department buildings were classed as 'temporary' with an intended lifespan of 10 years, they would continue to be used first by the science faculty and then later by the arts faculty until 1966.[591] Indeed, the research on university architecture by William Whyte gives an indication on how inadequate many university buildings in civic universities were and continued to be up until World War II.[592] Many of the grand architectural buildings of nineteenth-century civic universities had become dilapidated and facilities had become outdated. To accommodate departmental expansions temporary housing was created in re-assembled rooms and wooden army huts, and further laboratory space was sited in cellars and garages.[593] Therefore, regardless of the exterior appearance of the 'huts' at the Swansea

[584] RBA, UNI / SU / ACM / 3 / 2 / 1 / 4, p. 51.
[585] Dykes, p. 94.
[586] Dykes, p. 96.
[587] Richard Burton Archives, reference no: UNI / SU / ACM / 3 / 2 / 1 / 1 / 3, *University Council Minutes* (1922-23), 13 February 1922, p. 18.
[588] RBA, UNI / SU / ACM / 3 / 2 / 1 / 1 / 3, Dykes, p. 96.
[589] Richard Burton Archives, Swansea University, Box number: 666, (uncatalogued 3 of 4), L. Wright, *The Department of Physics University College of Swansea 1922-1945* (unpublished and not dated) p. 2.
[590] Wright, p. 2.
[591] RBA, Box no: 2013 / 12 / 4 (uncatalogued), Estates Department, *Consolidated Report on Academic Developments in the Quinquennium 1967-72* (May 1966), p. ii.
[592] Whyte, pp. 190-97.
[593] Whyte, p. 191.

institution, the buildings were new and designed for purpose with designated teaching and research spaces. The design was created by local Swansea Borough architect, Ernest Morgan (1881-1954), who co-ordinated with the scientific staff on the buildings' internal layout.[594] Morgan had previous experience with designing educational facilities, as he had designed the Swansea Technical College extension in 1910.[595]

Expertise was needed in the internal design of the physics laboratories as well, especially when attempting to create suitable research facilities in a limited space. This specialised knowledge was provided by the head of the department Professor Evans who used his skill in the design and equipping of the physics laboratories.[596] Evans' expertise was gained while working at his previous post at the Victoria University at Manchester, where under the leadership of the Nobel Prize winner, Professor Ernest Rutherford the department had established and developed a centre of excellence on radioactive research.[597] Consequently, Evans' experience of working in such a well-equipped and functional laboratories would benefit the science faculty at the Swansea institution, as he used the knowledge he acquired when putting together the designs for the Swansea Physics laboratories.[598] The establishment of working laboratories for the Physics Department was not the sole undertaking of Evans, as he was assisted by the department's senior lecturer, W. Morris Jones and the expertise of the technician, Frank Homeyard.[599] The provision of new and comprehensive apparatus and equipment ensured that the Swansea laboratories were well equipped by the standards of the day. Some of the equipment was further evidence of the influence of the Manchester Laboratory on Evans, as he used the same Manchester supplier for some of the essential equipment in the battery room.[600]

Furthermore, being a part of Rutherford's team gave Evans the invaluable experience of working with some of the foremost physicists researching in this field. The innovative research conducted at the laboratories during Evan's time there attracted the influential Danish physicist Niels Bohr (1885-1962), who joined the research team

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[594] Dykes, p. 96.
[595] West Glamorgan Archives, reference no: E/COLL S TECH/1, Morgan, Ernest E., *Plans for Swansea Technical College Extension* (1910).
[596] Augustine Edwin Owen, 'Evans, Evan Jenkin (1882-1944), physicist and university professor;' *in Dictionary of Welsh Biography* http://yba.llgc.org.uk [accessed 18 January 2018].
[597] Léon Rosenfield and Erik Rüdinger, 'The Decisive Years 1911-1918' in *Niels Bohr* ed. by Stefan Rozental (Amsterdam: North-Holland Publishing Company, 1967), pp. 43-5.
[598] Dykes, p. 96.
[599] Wright, pp. 5-6.
[600] Wright, pp. 5-6.

for four months in the spring of 1912.[601] While Rutherford's team worked on radioactivity Evans started concentrating his research on spectroscopy, and his work on the Pickering series produced measurements which supported Bohr's theory of the energy states of a hydrogen-like atom.[602] When World War I broke out Rutherford and his colleagues participated in a collaborative top secret World War I defence project, which involved conducting experiments in water tanks in laboratories at Manchester University to test underwater microphones.[603] A further full-scale testing programme conducted at a research outpost at Hawkcraig Scotland resulted in an early sonar prototype.[604] Rutherford's involvement in a war research programme gave Evans the opportunity to experience academic leadership as he stood in for Rutherford as head of the Physics Department during the war years.[605]

The university college's move to the site at Singleton Abbey was the seminal step towards establishing a permanent campus and gave the science faculty the opportunity to expand its facilities substantially.[606] However, the varied pressures involved with setting up new departments were not lessened with the move to the new campus, as departmental staff had to juggle the responsibilities of teaching with the duties of organising a new department. The problems generated by having to deal with often conflicting responsibilities are clearly stated by the Head of the Chemistry Department Professor Coates in a letter to the registrar.[607] Coates explains that the task of organising and costing the fitting out of the new department occupied a great deal of the chemistry staff's time, and implied that not enough was being done to ensure that the department would be ready to receive students by the next session. Such developments he warned could only be achieved if there was an urgent and immediate response to help the department, stating that there needed to be 'an immediate increase in the number of

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[601] Abraham Pais, *Niels Bohr's Times, In Physics, Philosophy, and Polity* (Oxford: Clarendon Press, 1991), pp. 124-28. 12 For further reading on the research conducted by Bohr and his involvement with Rutherford's laboratory at Manchester see: Helge Kragh, *Niels Bohr and the quantum atom: The Bohr Model of Atomic Structure 1913-1925* (Oxford: Oxford University Press, 2012).
[602] Wright, p. 6.
[603] Aeron Haworth, *Rutherford's secret war mission helped pioneer 'sonar'*, (11 November 2014) www.manchester.ac.uk>Discover>News [accessed 20 January 2018]. For further reading on Ernest Rutherford and his work see: John Betteley Birks, ed, *Rutherford at Manchester* (London: Heywood, 1962). Arthur Stewart Eve, *Rutherford, being the life and letters of the Rt. Hon. Lord Rutherford* (Cambridge: Cambridge University Press, 1939).
[604] Haworth.
[605] Owen.
[606] Wright, pp. 5-7.
[607] Richard Burton Archives, Swansea University, reference no: UNI / SU / AS / 2 / 1 / 33, J. E. Coates, *Letter to Registrar, Edwin Drew* (23 March 1922).

hands that can be usefully employed'. Addressing these problems was essential if the science departments were to fully engage in their work and research.[608]

Additionally, the creation of adequate research space at the institution was a crucial element in forming and developing a cohesive scientific community at the university college, especially in the form of individual laboratories for each specific scientific discipline. The impetus to delivering academic laboratory facilities in university institutions had evolved slowly since the late-nineteenth century.[609] In Britain the period before the First World War witnessed students and lecturers working in conditions that were unsafe, unsuitable, badly equipped and underfunded. The increasing need for laboratory space for specialised scientific disciplines such as chemistry and physics meant that university construction had to adapt to accommodate these facilities. With the prestige of science becoming firmly established during the inter-war years encouraged the provision of state funding and the creation of institutional space which focused on science laboratories. However, even with state-aided funding to construct laboratory space, the financial cost of fitting out and equipping individual laboratories to serve the various science disciplines was a significant burden on British universities.[610]

The laboratories at University College of Swansea were an example of this dilemma, as substantial investment was needed to establish a new science faculty. Although the construction of the building was funded by the local authority, the funding of furnishing, equipping, and supplying a stock of chemicals and other materials had to be borne by the university.[611] The financial report for the year ending 1921 stated that to furnish and equip the science buildings which were under construction would amount to approximately £20,000.[612] This was to be expected as by their very nature science departments were more expensive to equip than arts and humanities departments. The total amount spent on apparatus and materials by the science faculty for the 1921-22 session was £1,625, a significant amount when compared to the £90.00 spent by the Arts and Humanities Department in the same year.[613]

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[608] RBA, UNI / SU / AS / 2 / 1 / 33.
[609] Paul Gerbod, 'Resources and Management', in *A History of the University in Europe, Volume III,* ed., Walter Rüegg (Cambridge: Cambridge University Press, 2004), 83-100 (pp. 104-5).
[610] Gerbod, pp. 104-5.
[611] Richard Burton Archives, Swansea University, reference no. UNI / SU / AS / 2 / 1 / 19-20, *Finance*
[612] RBA, UNI / SU / AS / 2 / 1 / 19-20 / B38.
[613] Richard Burton Archives, Swansea University, reference no. UNI / SU / AS / 2 / 1 / 19-20, *Maintenance Grants for the Session 1921-22.*

The decision to invest money in the construction of teaching and research space for the science faculty came to fruition three years after the establishment of the university college. In July 1923 the industrialist and enthusiastic supporter of the university college, Sir Alfred Mond, MP addressed the opening ceremony of the new temporary science buildings at the University College, Swansea.[614] In his address the member of parliament reminisced over early discussions he had with Lord Haldane and other colleagues regarding the establishment of the university.[615] The conversations with Lord Haldane took place before the research of the 1916 Royal Commission on University Education in Wales got underway, and is an example of the informal networking that was being undertaken at government level on behalf of the proposed university college. In one of these early conversations Mond told Haldane that, ''if we only got what we were asking for, we should 'make good' in Swansea.'' In 1923 Mond reassured his audience that 'we have'.[616] Mond was referring specifically to the progress made on the Singleton Abbey site and the completion of the temporary buildings which would house on the science departments of metallurgy, physics and chemistry. The internal plan for the metallurgy department is illustrated in Appendix A and shows in detail specifically designated laboratories, and other facilities such as the library.[617] The site's completion was a physical representation of the efforts of the region's university movement, which prompted Mond to refer to the building's completion as being a tribute to those individuals whose enthusiasm and dedication had led to the establishment of a university college in Swansea.[618]

Funding Issues and the growth of Academic and Industrial Connections

The furnishing and equipping of the laboratories at the new site at Singleton Abbey put an added pressure on the university college's finances during the early years of the institution. However, this expenditure was essential to the success and development of the institution, and an assessment of this progress gives a clear indication of the health of the college's finances. Financial issues were a serious concern for the university college administration and its teaching staff, as by the end of the financial year of 1921

[614] Dykes, p. 96.
[615] Mond, pp. 1-3.
[616] Mond, pp. 1-3.
[617] Richard Burton Archives, Box number: 664, *Institute of Metals. Souvenir Swansea Autumn Meeting* (1922).
[618] Mond, pp. 1-3.

the college funds were already in deficit.[619] It was noted by the audited Statement of Accounts of the college that there was a deficit of £3276.13.2d. This was the consequence of the substantial initial expenditure that was needed to establish the university college. Yet the deficit was further exacerbated by the college having received only a partial grant from the University Council, as well as a delay of the grant which had been promised by the Treasury. The Treasury grant was in the form of matching any new endowment income and subscriptions which were guaranteed for five years.[620]

In addition to the shortfall in funding the pressure on the institution to create a comprehensive science faculty needed higher levels of funding to establish functioning departments. This is clear by the comparisons in the estimates for funding for the science and art faculties which are tabled below.[621]

Figure 2. Comparisons of Departmental and Laboratory Maintenance Expenditure

Department	Apparatus	Materials	Total
Mathematics	£10.00	£5.00	
Physics	£270.00	£60.00	
Chemistry	£150.00	£250.00	
Geology	£65.00	£125.00	
Biology	£75.00	£70.00	
Metallurgy	£140.00	£220.00	
Engineering	£200.00	£50.00	
Total	£910.00	£780.00	£1,690.00

Department	Apparatus & Materials
Classics	19.00
English	14.00
History	19.00
Welsh	29.00
Modern Languages	29.00
Education	-
Total	110.00

Reference: Richard Burton Archives, UNI / SU / AS / 2 / 1 / 15, Estimates for the year ending 30 June 1922

To add to the financial confusion there seemed to be an inconsistency in the messages given out by different committees to heads of departments regarding departmental spending. One example being; Professor Coates was given permission by the Buildings Committee (16 March 1923) to spend an extra £750 in addition to the grant of £1,000 for the purchase of essential equipment for the Chemistry department, while the Finance and General Purposes Committee (18 April 1923) stated that all heads of departments

[619] RBA, UNI / SU / AS / 2 / 1 / 19-20, *Finance.*
[620] RBA, UNI / SU / AS / 2 / 1 / 19-20
[621] RBA, reference no: UNI / SU / AS / 2 / 1 / 15, *Estimates for the year ending 30th June 1922. Departmental and Laboratory Maintenance.*

must take serious care in their spending for laboratory materials, books and the wages of laboratory assistants.[622] One consequence of these financial restrictions was that the laboratory 'boys' of the Chemistry and the Metallurgy departments lost their jobs.[623]

Yet, the financial health of the university college's during its early years was not a completely desperate situation, as the institution was in receipt of local endowments. A distinct source of endowment and subscription funding received by the other three constituent colleges of the University of Wales was also given to the Swansea institution. This funding came from working-class groups such as the miners and the Penrhyn and Dinorwic quarrymen, who gave financial support to the university colleges in their region.[624] Such funding sources helped define the University of Wales image of a public supported institution.[625] As with her sister colleges the Swansea college also received a substantial amount of public funding from industrial sources during the institution's establishment and the early years.[626] Yet, the provision of industrial financial support for the University College of Swansea was dissimilar to the earlier support given to the older constituent colleges, as the support was formally organised. Earlier industrial financial support for the university was haphazard in size, and regularity, as well as being inconsiderable when compared to private donations.[627]

What is apparent when assessing financial support in the industrial and college archives is the determination of local industrialists to support the new college in an organised and systematic way. A system of organised industrial monetary collection is apparent from the minutes taken at a Directors meeting held at Ashburnham Tinplate works office on 30 September 1920.[628] Item 4 of the minutes states:

> The Tinplate conference having recommended that the Tinplate Trade as a whole should contribute to the funds of Swansea University on the basis of £5 per mill per annum. Resolved that we accept the recommendation that a cheque for £20 to clear this year's subscription be issued forthwith.[629]

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[622] Richard Burton Archives, Swansea University, reference no: LAC / 115 / 3, *Buildings Committee* (16 March 1923*)*, p. 60. *Finance and General Purposes Committee* (18 April 1923), p. 72.
[623] RBA, LAC / 115 / 3, *Finance and General Purposes Committee,* p. 73.
[624] Thomas, p. 31.
[625] Thomas, p. 31.
[626] RBA, UNI / SU / AS / 2 / 1 / 15.
[627] Thomas, pp. 30-1.
[628] Richard Burton Archives, Swansea University, reference no: LAC / 4 / 3, Ashburnham Tinplate Company, *Directors Meetings Minute Book,* (September 30, 1920), p. 165.
[629] RBA, LAC / 4 / 3, 165.

The recommendation was accepted and acted on within the year by forty-five of the tinplate mills with the annual subscriptions being guaranteed for at least five years. This was not the sum total of financial support from the tinplate industry, as larger single endowments were presented to the university college and appropriated for the science temporary buildings and equipment.[630] An acknowledgement of the extent of local industrial financial support was noted in a pamphlet produced by the university college for the Universities Bureau of the British Empire.[631] The document states that the amounts were substantial, with single payments totalling £4,700 received in 1920 and annual subscriptions of £6, 638.16, a total that was promised for a further five years.[632] The details of income from private donations and capital benefactions that was received by the new institution from 1918 to 1921 are detailed in Appendix B (i) and B (ii).[633]

Such immediate and organised industrial funding for the college was partly due to the efforts of the council of the newly formed college. The council under the presidency of the industrialist Francis William Gilbertson decided to take pro-active measures to solicit the continued support of local industry. At a meeting of the college's finance committee on 10 June 1920 it was agreed that the president of the college should issue invitations to local manufacturers to a meeting at the Swansea Metal Exchange on 22 June to discuss industrial support of the college. Those who attended would be addressed by Gilbertson, who in his role as president had overall responsibility for the executive management of the university college, and Principal Sibly.[634] Whatever was expressed at the meeting by Gilbertson and Sibly had the desired effect on the industrialists and cemented their resolve, and role in the public finance of the university college. Further steps were taken by the college council to elicit funding by requesting that council members Alderman Ivor H. Gwynne and his colleague W. J. Davies contact the organised Trades for their support.[635] Gwynne's long-standing role as secretary of the Tin and Sheet Millmens' Association would have helped him work with the Trades to establish a network of financial support for the university college.

[630] RBA, reference no: UNI / SU / AS / 2 / 1, *Income from private gifts and Endowments during the financial year ending June 30, 1921, Capital Benefactions for sites, buildings and permanent equipment.*
[631] RBA, reference no: UNI / SU / AS / 2 / 1 / 27, *Universities of the British Empire*, p. 9. The Universities of the British Empire was established in 1913, the oldest international network of universities.
[632] RBA, UNI / SU / AS / 2 / 1 / 27, p. 9.
[633] RBA / UNI / SU / AS / 2 / 1 / 15, *Income from private gifts and Endowments. Capital Benefactions for sites, buildings and permanent equipment.*
[634] RBA, LAC / 4 / 3, *Finance Committee.*
[635] RBA, LAC / 4 / 3.

The collaboration that was undertaken by both academics and local politicians with the region's industry would continue to generate financial support for the institution throughout its first decade. In 1925 some of the university college's industrial backers who had financially supported the institution for its first five years gave assurances for a further five years of subscriptions and in a few cases a further 7 years was promised.[636] A few extended their subscriptions, notably the Cleeves Western Valleys Anthracite Collieries Ltd who promised by deed £500 per annum for a further 7 years and the South Wales Siemens Steel Association assured by deed £2,500 per annum for the same length of time.[637] Siemens' subscription came with a caveat, which was that out of their £2,500 annual subscription £1,200 had to be reserved for research into metallurgical problems.[638] However, by the end of the decade industrial subscriptions started to decline as the national economic depression continued to have an effect on export-orientated industries, particularly the coal, iron and steel industries.[639] The effect of new foreign markets and declining exports on the coal industry in Wales was exceptionally harsh, with many collieries closing or surviving by operating on a system of short-time working.[640]

The details of the industrial financial support for the university college show a complex but a contradictory narrative: whereas there was substantial and regular support from many local works and businesses, individual donations from leaders of the industrial and commercial world were not so forthcoming. Apart from personal endowments from leading industrialists such as Sir Alfred Mond and Herbert Eccles, chairman of the Briton Ferry Steel Company who both donated £2,500, personal donations very rarely amounted to £1000.[641] While the endowment fund for the college passed its earlier target of £40,000, due to the reticence of certain industrialists the endowment fund never reached the later target of £70,000.[642] Criticism and questions about the commitment of certain leading industrialists and businessmen to the financial development of the university college were raised in 1922 at a meeting of the Institute

[636] RBA, reference no: UNI / SU / AS / 2 / 1 / 68, *List of Subscribers* (1925).
[637] RBA, UNI / SU / AS / 2 / 1 / 68.
[638] Richard Burton Archives, Swansea University, *Annual Reports 1929-1932* (Swansea: Ernest Davies & Co., Ltd., 1932), p. 73.
[639] Stephen N. Broadberry, *The British Economy Between the Wars. A Macroeconomic Survey* (Oxford: Basil Blackwell Ltd., 1986), pp. 5-6.
[640] G. Humphrys, 'Extractive Industry: Coal Mining', in *Swansea and its Region* ed. by W. G. V. Balchin (Swansea: University College of Swansea, 1971), 225-240 (p. 228).
[641] Dykes, p. 67.
[642] Dykes, pp. 66-67.

of Metals at Swansea.[643] The speaker stated that the commitments of many industrial and commercial leaders had not changed since 1914, and as such only considered their own works and businesses instead of the 'good of their community'.[644] Thereby, the University College, Swansea did not receive the largesse of wealthy individuals or families such as experienced by Bristol University with the Wills family.[645]

Academic and Industrial Research

The significance of developing connections with industry was not just about the university college receiving financial support, it was also important to establishing a working network between local industries and the science faculty. Evidence of how important an academic/industrial network was to the future ambitions of the college is expressed in the previously mentioned pamphlet produced for the Universities Bureau of the British Empire by the institution.[646] The document states clearly the intentions of the Swansea institution noting that 'The College possess the means of building up a great school of metallurgy, working in the closest co-operation with industries at its very door'.[647] Yet, while such intentions of the college were a progressive move in the University of Wales's relations with the heavy industrial sector, there was the potential for disagreement between the two parties regarding research objectives. This was due to the fundamental difference between the role and focus of research within the academic and industrial space.[648] Scientists who were based in universities operated within the institutions' mission of the pursuit, advancement and dissemination of knowledge, in which research was undertaken from an impartial stance with no commercial application. While within the industrial setting scientific research was undertaken and applied with commercial purposes in mind.[649]

Regardless of any reservations about conflicting interests the council of the University College of Swansea was determined that 'specific' research would be undertaken for associations and firms (and individuals), on the condition that there was

[643] Richard Burton Archives, Box no. 664 / 1 / 312 / 1, *The Institute of Metals. Souvenir Swansea Autumn Meeting* (1922), p. 17.
[644] RBA, 664 / 1 / 312 / 1, *The Institute of Metals.*
[645] Sanderson, The Universities and British Industry. p. 73.
[646] Richard Burton Archives, reference no: UNI / SU / AS / 2 / 1 / 27, *Universities Bureau of the British Empire*, p. 9.
[647] RBA, UNI / SU / AS / 2 / 1 / 27, *Universities Bureau*, p. 9.
[648] Cotgrove and Box, pp. 1-2.
[649] Cotgrove and Box, p. 2.

no expense to the university.[650] Assessing the feasibility of specific projects was the prerogative of Professor Edwards, who was given executive powers to do this by the Council.[651] The executive powers given to Edwards in selecting research projects was an example of the contemporary entrenched hierarchical structure of science departments in British universities. The development of science departments in British universities had established a strict ranking system in which the authority of the head of department extended to deciding what scientific research was undertaken.[652] The 1984 study on the scientist's role in society by Joseph Ben-David argues that this system was a restriction on the scope of research projects undertaken in British universities. The British system was contrary to the American system where a head of department dealt with the administrative side of the department, which was of a sufficient size to incorporate the work of a number of professors and allow the growth of independent projects within one department.[653] The British departmental set-up ensured that it was the senior staff of the University college's science faculty that were involved in implementing academic/industrial collaborations.

On his acceptance as head of the metallurgy department Professor C. A. Edwards noted the financial support for the university college from local industry, as well as from industrial societies such as the Engineers and Iron Founders Associations.[654] Consequently, Edwards indicated to Principal Sibly that he wished to meet with local industrial associations and societies, as well as indicating that he wished to be involved in any collaborative discussions between the university and industry.[655] In many ways Edwards was well positioned to be involved with establishing and developing networks with industry; part of his career included experiencing practical experience of working within heavy industry, both as an apprenticeship in the Lancashire and Yorkshire railways foundry and with the Middlesborough Iron and Steel works, Bolckow Vaughan Co. Ltd.[656] By the 1900's Bolckow Vaughan was one of the largest steel producers in

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[650] RBA, UNI / SU / ACM / 3 / 1 / 1 / 3, *Council Minutes 1921 / 22*, p. 2.
[651] RBA, UNI / SU / ACM / 3 / 1 / 1 / 3.
[652] Joseph Ben-David, *The Scientist's Role in Society A Comparative Study* (Chicago and London: The University of Chicago Press, 1984), pp. 154-5.
[653] Ben-David, p. 155.
[654] Richard Burton Archives, file no. UNI / SU / AS / 2 / 1 / 3, *Correspondence from C.A. Edwards to Principal Sibly* (23 July 1920).
[655] RBA, UNI / SU / AS / 2 / 1 / 3, *C. A. Edward's Correspondence.*
[656] Donald Walter Hopkins, 'Edwards, Charles Alfred (1882-1960), metallurgist and principle of University College of Swansea' in *Dictionary of Welsh Biography* (2001), http://yba.llgc.org.uk [accessed 30 April 2018).

Britain achieving the status by 1907 of being Britain's largest employer with 20,000 workers.[657] Edwards had already published research on the heat treatment of steel when in 1910 he began working at Bolckow Vaughan which offered Edwards further opportunity for research.[658]

With his appointment at the University College of Swansea Edwards deep interest in metallurgy was extended to the local industry of tin plate and black plate manufacture.[659] Facilitating relations between academia and industry was further encouraged by initiating and building contacts between academia and regional, as well as national industrial associations and societies. An opportunity for the University College of Swansea to do this presented itself in 1922, when the national organisation, The Institute of Metals visited Swansea for its Autumn meeting.[660] During the three-day conference, the financial involvement of South Wales industry in securing a university college at Swansea was acknowledged as was the commitment by F. W. Gilbertson and his colleagues in the metallurgical industry. The reception committee for the conference was a collaboration of representatives from the university college, industry, and local government, as well as the Chamber of Commerce. Attending the conference were members from local industrial societies such as the South Wales Siemens Steel Association, Welsh Plate & Sheet Manufacturers' Association, Spelter Association, and the Copper Association.[661]

The conference had a national flavour as the academics and industrialists who gave papers were from the wider world of industry and academia, and represented the industrial cities of Glasgow, Birmingham and Sheffield and the academic centres of London and Cambridge.[662] Further opportunities were arranged for both academics and industrialists to network with each other in an informal setting. The reception committee organised visits to local industrial works and the science faculty at the university college, where it was arranged for delegates to meet all staff members of the Metallurgical Department.[663] In addition to listening to research papers, the time-frame of the conference allowed delegates the opportunity to discuss the wider issues

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[657] Marianne Pitts, *How are the mighty fallen: Bolckow Vaughan Co. Ltd. 1864-1929* (Warwick Business School, 2007), p. 5.
[658] Hopkins.
[659] Pfeil, p. 35.
[660] Richard Burton Archives, Swansea University, Box no. 664 uncatalogued 1 of 3, *The Institute of Metals. Souvenir Swansea Autumn Meeting* (1922), p. 3.
[661] RBA, 664 / 1 / 3, *The Institute of Metals*, pp. 17 and 32.
[662] RBA, 664 / 1 / 3, *The Institute of Metals*, pp. 3-6.
[663] RBA, 664 / 1 / 3, *The Institute of Metals*, pp. 7 and 9.

connected to industrial development. Post-war conditions of falling rates of exchange and the lack of foreign buyers had a detrimental effect on industry and none more so than the heavy industry of South Wales.[664] While 80% of British tinplate was manufactured in the Swansea region, many of the mills along with other metal-working industries were only operating at 50% capacity. However, the opportunity for future academic/ industrial connections was presented by the establishment of the first oil refinery using imported crude oil in Britain, National Oil Refineries at Llandarcy near Swansea.[665]

The success of the refinery was impressive with a 50% increase in its output achieved within the first 15 months, and construction at the Swansea port ensured further expansion.[666] The Swansea port was used as the chief port of import in Britain, and special facilities were constructed at the docks so as to enable up to four tankers to discharge their crude oil or to be loaded at a time.[667] The opportunities that the fuel industry offered academia in different areas of scientific study and research were recognised by Professor Coates, who suggested that Swansea should develop a special study of fuel which could connect the departments of Engineering, Metallurgy, Geology and Chemistry.[668] The university college launched various initiatives to strengthen the connections that had been established between the institution and the different industries in the locality.[669] One of these involved setting up of university-based advisory committees to 'promote understanding and co-operation' with different localised industries.[670] Senior members of staff were involved in this initiative and their participation included chairing the meetings, as well as being the institution's contact point for local industries. Principal Sibly and Professor Edwards maintained close communication with practical industries, and Professor F. Bacon the Head of Engineering was the contact for engineering firms.[671]

One of these advisory groups which was successful in delivering its remit of furthering academic/ industrial relations in the Swansea area was the Non-Ferrous

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[664] RBA, 664 / 1 / 3, *The Institute of Metals*, p. 25.
[665] Graham Humphrys, 'Industrial Wales' *in Wales A New Study*, ed. by David Thomas (London: David & Charles, 1977), pp. 175-76.
[666] RBA, 664 / 1 / 3, p. 25.
[667] Humphrys, p. 176.
[668] RBA, UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments with Reference to the Future Needs and Projects of the College* (13 March 1925).
[669] RBA, UNI / SU / AS / 2 / 1 / 3 / A7.
[670] RBA, 664 / 1 / 3, p. 32.
[671] RBA, 664 / 1 / 3, p. 32.

Metallurgy Advisory Committee.[672] The committee was a collaboration of staff members of the university college, industrial associations, and industrial firms. Part of the committee's remit was to investigate the way in which the college could best assist the regional industries, especially in relation to scientific research and development. The committee requested a report from Sibly and Edwards, to assess the conditions under which the metallurgy department was able to undertake specific research projects for industry, in particular the tinplate industry.[673]

What specific arrangements were made between the tinplate industry and the metallurgy department is difficult to determine, as no documentation has come to light that discusses any contracts between the university college and local industrial plants. Yet, there are indicators to the type of research that was needed, as a Joint Industrial Council report in 1920 stated that there was an urgent need to modernise the industry.[674] Modernisation was required in both areas of production expansion and technical expertise, as well as an overall of the working conditions in the plants which had become so deplorable that the industry suffered recruitment problems.[675] In addition, evidence of the institution's response to these difficulties can be found in an evaluation of the Metallurgy department's published research from 1921, which dealt with technological problems of the industry.[676] Associated metallographic problems such as the difficulties associated with the deep pressing properties of steel sheet prompted joint research by Edwards and his lecturer, Leonard Pfeil, which was partly funded by the Carnegie Scholarship fund of the Iron and Steel Institute.[677] Long-term research conducted at the University College of Swansea on the processes of tinplate technology supported the industry's modernisation and the successful introduction of the continuous strip process in the late 1930s.[678]

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[672] RBA, Council Committees, reference no. LAC / 115 / 3, *Non-Ferrous Metallurgy Advisory Committee* (21 September 1921), item no. 388.
[673] RBA, LAC / 115 / 3 / 388.
[674] Warwick Modern Records, University of Warwick, reference no: MSS. 36/2003/55, file no: T18 / 12, *Joint Industrial Council for the Welsh Plate & Sheet Trades* (June 1920), p. 2.
[675] WMR, MSS. 36/2003/55, t18 / 12.
[676] Pfeil, p. 37.
[677] N. P. Allen, 'Leonard Bessemer Pfeil, 1898-1969', *Biographical Memoirs of Fellows of the Royal Society* vol. 18 (1972), 476-487 http://rsbm.royalsocietypublishing.org/subscriptions [accessed 07 June 2018], p. 478. Published research by Edwards and Pfeil: 'A note on coarse crystallisation in mild steel sheets', *J. Iron & Steel Institute* vol. 108 (1923). 'The tensile properties of single iron crystals and the influence if crystal size upon the tensile properties of iron', *J. Iron & Steel Institute* vol. 112 (1925).
[678] Collins, G., and M. N. Patten, 'Industry: The Technological Background' in W. G. V. Balchin, ed., *Swansea and its Region* (Swansea: University College of Swansea, 1971), 241-254 (p. 246).

Industry's part in facilitating a close relationship with the college included the arrangement of visits to individual industrial works by staff and students of the college.[679] Such visits to local industrial works were often organised as an activity for a student society. By 1930 the students Chemical Society were making numerous trips each academic year to varied industrial works, that included Hafod Sulphuric works, British Oxygen Co. Ltd, Mond Nickel Co. Ltd and Buckley's Brewery at Llanelli.[680] The university facilitated meetings between different industrial organisations, as well as providing an independent space for their members to meet. An early example of such a meeting was held at the university on 6 February 1923 between members of the Swansea Metallurgical Society and The Society of Chemical Industry.[681]

Consolidating academic/industrial connections which could generate co-operation was also conducted in the informal space of industrial society meetings. One such society was the Swansea and District Metallurgical Society (founded in May 1919), an organisation which held regular meetings in which university academics were invited to deliver papers on their research.[682] The small-scale beginning of the new science faculty did not hinder the publication of scientific research undertaken at the university college. The science departments cultivated their academic reputations by organising and undertaking research projects supported by the publication of research papers. As early as 1923 the Chemistry department had its research published in the *Journal of the Chemical Society.*[683] Throughout the institution's first decade the staff and research students of the science faculty had research papers published in the publications of societies of the different disciplines. [684]

One prolific writer of publications and published reports was Emily Dix (1904-1972) who published first as a research student and then as a staff member in the Geology department.[685] As with most of her fellow students in the Geology department Dix was born and educated in South Wales, however she was the first female student in

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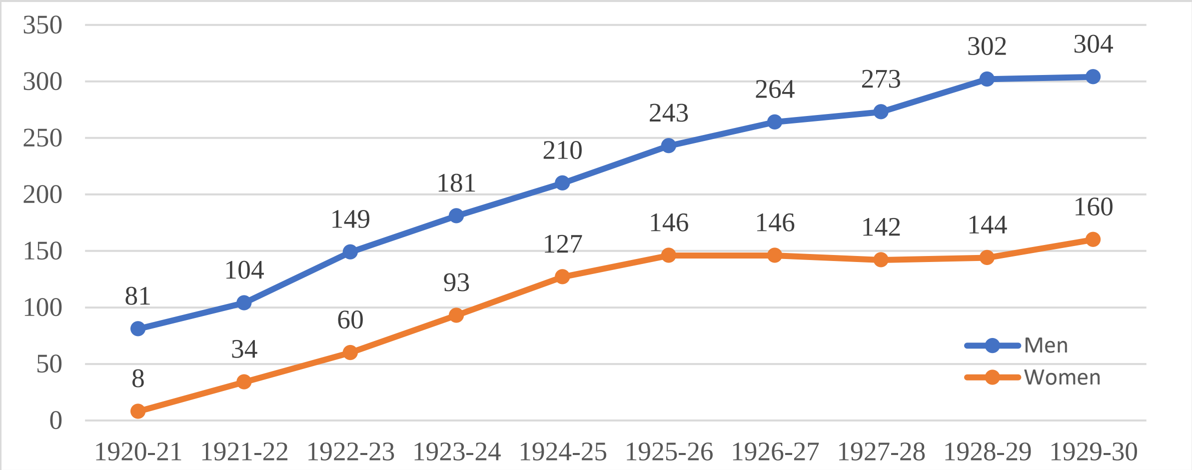
[679] RBA, LAC / 115 / 3 / 388.
[680] Richard Burton Archives, Swansea University, ref. Reports of the Council presented to the Court of Governors 1929-1932, *Tenth Annual Report 1930* (uncatalogued), p. 19.
[681] Richard Burton Archives, Swansea University, reference no: LAC / 74, file no: A2, *Metallurgical Society.*
[682] RBA, LAC / 74 / A1-A3.
[683] Richard Burton Archives, Box no: 583, reference no: 2A, *University College of Swansea, Department of Chemistry,* p. 7.
[684] University College of Swansea, Reports of the Council, 1920-1930.
[685] Cynthia V. Burek and Christopher J. Cleal, 'The Life and Work of Emily Dix (1904-1972)' *Geological Society, Special Publications,* 241 (2005), 181-196.

the department.[686] The University of Wales had specified in the first clause of its charter that there were to be equal opportunities for female students,[687] Indeed, the charter also stipulated that all the offices within the institution were to be open equally to women as well.[688] Yet, there were early signs in the planning of the University College, Swansea that plans to accommodate female staff and students were lacking. As noted by the 1918 Haldane Report who urged the promoters of the proposed Swansea institution to increase their plans to address the needs of future female students.[689] In fact, apart from Mockeridge and Irene Hilton who was appointed as Assistant Lecturer in zoology in 1923, no other female scientists were appointed at the institution during the 1920s.[690] Yet, this was the reality at higher education institutions, as for many women the conventions of contemporary society were a barrier to accessing higher education.[691]

The continuing inequality is expressed in the ratio of female students to male students attending the academic sessions during the institution's first decade. The graph below details the smaller ratio of female students to male which continued through the first two decades of the institution's history.

Figure 3. University College Swansea, Full Time Students Gender Comparison 1920 - 1930



Reference no: Richard Burton Archives, UNI / SU / AS / 1 / 1 / 77, *Growth of the College*

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[686] Derek Ager, *Three Score Years and Ten of Geology at Swansea* (unpublished).
[687] National Library of Wales Archive, National Library of Wales, Aberystwyth, University of Wales Archives, reference no: S4 / 1, *University Senate Meetings* (1894).
[688] J. Gwynn Williams, *The University Movement in Wales* (Cardiff: University of Wales Press, 1993), p. 150.
[689] Royal Commission on the Education in Wales, *Final Report of the Commissioners* (London: Her Majesty's Stationary Office, 1918), p. 75.
[690] RBA, LAC / 115 / 3, *Minutes of Meeting of Committee of Council* (13 September 1923).
[691] Williams, p. 191. For further reading on women's experience of working within academia see: Pnina G. Aber-Am and Dorinda Outram, eds, *Uneasy Careers and Intimate Lives. Women in Science, 1789-1979* (New Brunswick and London: Rutgers University Press, 1987).

Emily Dix achieved success in the male dominated world of the Geology department. As a student Dix was supported and supervised by her head of department, Arthur Trueman, and followed his lead in the study of the theory of Carboniferous stratigraphy.[692] Her study on *The Palaeontology of the Lower Coal Series of Carmarthen and the Correlation of the Coal Measures in the Western Portion of the South Wales Coalfield* awarded her an MSc, which was later published in 1928 in the *Proceedings of the South Wales Institute of Engineers*. As well as publishing in her own right Dix co-authored with other geologists, most notably with Trueman who published nine papers jointly with Dix.[693]

The Development of Research Resources

While there had been progress within the science departments in establishing their research credentials, there was a serious obstacle to continuing this progress. The heads of the chemistry and physics departments, Professors Evans and Coates reported in 1925 that the library provision for both departments were inadequate.[694] Coates was explicit in his concerns, stating that ‘research in the department is considerably hampered by the lack of back volumes of journals, and works of reference’. Important journals such as *Zeitschrift für Physikalische Chemie* and *Zeitschrift für Elektrochemie* as well as back copies of journals from the Faraday Society were certainly needed for teaching and research in the Chemistry department.[695] The importance of scientific journals cannot be underestimated because as well as storing and communicating research, the publications were increasingly the medium through which individual or team research was recognised, and thereby, establishing reputations and careers.[696] However, the Swansea science faculty was not alone in its limited library facilities. In a document entitled a ‘*Report on Facilities for Advance Studies and Research’* compiled in 1926 by the Association of Teachers there is concern regarding the deficiency of

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[692] Burek and Cleal, pp. 181-82.
[693] Burek and Cleal, p. 182. For further reading on issues of gender and women in science during the early part of the Twentieth Century see: Ruth Watts, *Women in Science: a Social and Cultural History* (London and New York, Routledge, 2007). Mary R. S. Rees, ‘British Women of the Nineteenth and early Twentieth Centuries who contributed to Research in the Chemical Sciences’ *The British Journal for the History of Science*, 24 (1991), 275-305.
[694] Richard Burton Archives, Swansea University, reference no: UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments with reference to the future needs and projects of the College* (13 March 1925).
[695] UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments*.
[696] Aileen Fyfe, Julie McDougall-Waters and Noah Moxham, ‘350 Years of Scientific Periodicals’ *The Royal Society Publishing*, 69 (2015), 227-239 (p. 227).

library amenities at many of the universities in Britain.[697] The limited scientific reference and journals at academic libraries was not just due to financial restraints, the post-war cultural boycott had a negative effect on the supply of German published material.[698] Furthermore, the dire economic climate in Germany which led to the hyperinflation of 1923 resulted in extremely high prices of goods including items that affected the academic world, paper and publications.[699]

The Association of Teachers' document stated that it was important for universities to provide a well-equipped library for all faculties, and suggests that 'universities are more or less awakening to the necessity of making substantial grants for this part of their equipment'.[700] This was a course of action taken by the Senate of the University College of Swansea, when in 1925 it appropriated a special grant of £2000 (plus the added interest of £20) from HM Treasury for the purchase of books, periodicals and binding for the different disciplines in the humanities and the sciences.[701] The portion of the grant allocated to the science faculty was distributed quite evenly between the separate departments, with £130 for research literature for both the Physics and Chemistry departments, £110 for biology and metallurgy and £100 for geology.[702]

The binding of journals was of immediate concern at the university college, as the frequent usage of unbound scientific journals was causing a deterioration in their condition.[703] The purchasing and care of the journals rested with the librarian Olive Busby (1894-1984), who highlighted that the cost of binding current journals put a serious drain on the funding that was allocated to library resources.[704] Indeed the librarian had to make the decision to either pay for the binding of current journals or to procure new academic books for the library. As previously noted in the chapter the £2,000 state grant enabled the faculties to increase the numbers of specific books for

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[697] Richard Burton Archives, Swansea University, reference no: UNI / SU / AS / 2 / 1 / 67, *Association of University Teachers, 'Report on Facilities for Advanced Study and Research'* (Leeds: Jowett & Sowry Ltd, 1925), p. 10.
[698] Elisabeth Piller, ''Can the Science of the World Allow this?'': German Academic Distress, Foreign Aid and the Cultural Demobilization of the Academic World, 1919-1925' in *The Academic World in the Era of the Great War*, eds., Marie-Eve Chagnon and Tomás Irish (London: Palgrave Macmillan, 2018), 189-212, (pp. 192-94). For further reading on post-war intellectual relief during the 1920s see: Tomás Irish, 'The "Moral Basis" of Reconstruction? Humanitarianism, Intellectual Relief and the League of Nations, 1918-1925' *Modern Intellectual History* (2019), 1-32.
[699] Piller, p. 193.
[700] RBA, UNI / SU / AS / 2 / 1 / 67, F15, p. 10.
[701] Richard Burton Archives, Swansea University, UNI / SU / AS / 2 / 1 / 76, *Memorandum from the Senate.*
[702] RBA, UNI / SU / AS / 2 / 1 / 76, *Senate Memorandum.*
[703] RBA, UNI / SU / AS / 2 / 1 / 67 / F124.
[704] RBA, UNI / SU / AS / 2 / 1 / 67 / F34.

their departments. However, Miss Busby wished to allocate a portion of the grant to pay for the binding of the increasing quantity of back journals that were accumulating in the library. By dealing with the backlog the cost of binding future journal volumes could be met by annual grants.[705]

The provision of an adequate library that served the needs of the different disciplines in the science faculty was essential for research, but there was another facility which was required for research in the disciplines of geology and botany. This was a university museum, where the provision of such a space had already been accounted for in the architect's plans for the science buildings.[706] Even before the science buildings had been constructed, the Geology department had acquired museum specimens, with the gift of rocks and fossils donated by Principal Sibly and Dr Catherine A. Raisin (1855-1945).[707] As well as being an advocate for the advancement and equality of women in education, Raisin was an important geologist.[708] Apart from her extensive work in microscopic petrology and mineralogy, Raisin's achievements in her academic career included being the first woman in Britain to become the head of a Geology department (Bedford College), and the first female academic to be awarded a fellowship in the Geological Society.[709] Raisin's retirement in 1920 probably prompted her gift of geological specimens to the newly established college at Swansea, an institution that Raisin appears to have had no academic or personal connections with.

Throughout the university college's first decade the museum collection greatly increased, and the problems of arranging and preserving collections became apparent, especially as the department started receiving specimens from abroad. In 1926 a consignment of tropical specimens arrived from Ceylon.[710] To assist with collection preservation a visit by Harold Augustus Hyde (1892-1973), keeper of the Botanical section of the National Museum of Wales was arranged. Hyde discussed the methods used by the National Museum to collect and preserve herbarium and other species.[711]

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705 RBA, UNI / SU / AS / 2 / 1 / 67 / F34.
706 RBA, 664 / 1 / 312 / 1, *The Institute of Metals*.
707 Richard Burton Archives, Swansea University, reference no: LAC / 115 / 2, *University College Swansea Council Minutes* (17 October 1921), p. 4.
708 Mary R. S. Creese and Thomas M. Creese, 'British Women who Contributed to Research in the Geological Sciences in the Nineteenth Century' *The British Society for the History of Science*, 27. 1 (1994), 23-54 (pp. 35-6).
709 Creese and Creese, p. 36.
710 Richard Burton Archives, Swansea University, ref: Annual Reports 1925 – 1928, *6th Annual Report, 12 November 1926*, p. 15.
711 RBA, Annual Reports 1925 – 1928 (1926), p. 14.

The National Museum was also proactive in extending the university college's museum by donating specimens of fossil plants from the David Davies Collection.[712] Further valuable contributions of biological specimens were received from research institutions such as the Royal Gardens at Kew, notably the collection of Ferns and Gymnosperms sent by the Director of Kew to the Biology department.[713] However, donations were not always received from academic and research sources, an example being the presentations from the 1925 British Empire Exhibition Wembley presented to the Biology Department.[714]

One donation in 1924 affected the layout of the museum. The relatives of a deceased London amateur geologist, T. V. Reader (1860-1923) presented his extensive rocks and fossils collection to the university college.[715] Reader's collection consisted of more than 40,000 specimens, with many items considered to be of significant value to future research.[716] The size of the collection was too large to be displayed in the museum room, which was already becoming inadequate for accommodating and displaying the increasing numbers of botanical and geological specimens.[717] Therefore when extra room was made available in the science block, the Geology department acquired space to establish a small research laboratory and room to hold the Reader Collection. The collection formed the central element of the geological museum of the department.[718] By the end of the decade the geology collections of the museum were firmly established, being housed and displayed in new cabinets purchased from a special grant from the college Council.[719] While the establishment of departmental museums at the university college was seen by both Trueman and Mockeridge as an important

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[712] RBA, Annual Reports 1925 – 1928 (1927), p. 74.
[713] Richard Burton Archives, Swansea University, ref: Reports of the Council presented to the Court of Governors, *4th Annual Report, 21 November 1924*, p. 9.
[714] RBA, ref: Reports of the Council presented to the Court of Governors, *5th Annual Report,1925*, p. 12.
[715] RBA, ref: Reports of the Council presented to the Court of Governors, *4th Annual Report, 21 November 1924*, p. 22.
Thomas William Reader (1860-1923) combined his enthusiasm for geology with his passion for photography, compiling a series of 12 albums which featured photographs of the Geologist Association field trips between 1907-1919. A member of the GA since 1903 Reader was the first recipient of the GGA'S Foulerton Award for work of merit. Reader's albums are now in the Geologists' Association Carreck archive.
[716] RBA, *4th Annual Report*, p. 22.
[717] RBA, *4th Annual Report*, p. 9
[718] RBA, *5th Annual Report*, p. 28.
[719] RBA, *10th Annual Report*, p. 33.

development for teaching and research, they also considered the facility as a resource for the wider public.[720]

Federal and Community Connections

As well as developing connections with the wider community of Swansea, the University College of Swansea had to establish itself within the federal system of the University of Wales. According to Professor R. H. Williams the college quickly became assimilated into the federal system, though he criticised the governance of the University of Wales in relation to its constituent colleges.[721] Williams argued that academic developments were often compromised by inter-college rivalries and jealousies.[722] While there are those who would disagree with William's view, it is clear that the federal system of the University of Wales increasingly demanded compromise between the four constituent colleges especially in relation to their individual curriculum. As the University College, Swansea was the latest addition to an established federal system certain curriculum compromises were expected of the institution's during its first decade. During 1926 the Senate of the University invested considerable time in discussing whether the applied sciences should be divided between the constituent colleges of Cardiff and Swansea.[723]

Underlying these discussions was a drive for efficiency and to economise funding within the university. While the Senate recognised the necessity of keeping metallurgy studies at the college at Swansea, they decided that any future department of mining should be based at Cardiff. However, it was made quite clear to the Swansea college authorities that they must not make any attempt to provide mining studies.[724] Making such a deliberate threat to the Swansea institution regarding its curriculum was an example of the university's increasing desire for compromise, and not in keeping with the university's earlier ethos of flexibility for the colleges' to determine their curriculum choices to coincide with local educational needs.[725] However, underlying the

[720] RBA, reference no: UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments with reference to the future needs and projects of the College* (13 March 1925).
[721] Swansea University Pamphlets, Box no: W/ LD – W/ LF1145, ref. no: W/ LF1145, R. H. Williams, *Our University at the Turn of the Century* (Eisteddfod Court, 1996), p. 7.
[722] Williams, p. 7.
[723] RBA, UNI / SU / AS / 2 / 1 / 93, *The Applied Sciences* (1926).
[724] RBA, UNI / SU / AS / 2 / 1 / 93, *The Applied Sciences.*
[725] Richard Burton Archives, reference no. 665 / 4, *Royal Commission on University Education in Wales* (1918), p. 27. Swansea University Library Pamphlets, reference no; W/ LF1157-1220, no: W/ LF1178.5,

Senate's stance on the provision of higher education in mining was a previous understanding with Principal Sibly of the University College, Swansea.[726]

In 1922 the debates and discussions around the provision of mining education and research had reached such a level of concern that a conference was held at Swansea to discuss the implementation of this area of higher education.[727] Previously the County Council of Glamorgan had approached the Council of the University College of Swansea to determine whether the institution could establish a department of Mining which would offer teaching and research in mining and mining engineering.[728] At this point in its development the college was unable to consider the request due to limited and finance. As all technical teaching was being undertaken at the Swansea Technical College, and to build specialised facilities for mining teaching and research it was estimated that it would cost approximately £100,000.[729] However, Sibly was aware that under certain recommendations of the Sankey Committee funds would be available to support any future mining educational developments in Swansea.[730] Even so, while recognising that Swansea had a superior claim to establish scientific studies to support the mining industry due to its experienced engineering staff and its proximity to extensive coalfields, Sibly decided to defer to the prior plans of Cardiff.[731] This move was a diplomatic one, as by ensuring Swansea would not participate in mining educational schemes it would give Cardiff an opportunity to establish and develop its own plans. As a supporter of the federal system of the university it was important to Sibly to ensure that the co-operative and positive relationship between the two constituent colleges was maintained.[732] With Sibly resigning in 1926, the university Senate re-enforced the previous understanding with the Swansea institution and its new Principal, Professor Charles Edwards.

Another significant compromise that the Swansea college had to make to the curricula of its science faculty was to curtail plans to establish a department of Geography. Since its establishment the college at Swansea had determined that

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Henry Jones, *An Address on 'The Higher Learning in its bearing upon National Life in Wales'* (Bangor: Jarvis & Foster, 1895), p. 9.

[726] RBA, UNI / SU / AS / 2 / 1 / 39, *Department of Higher Education in Mining,* pp. 11-12.

[727] RBA, UNI / SU / AS / 2 / 1 / 39, *Conference on Mining Education* (27 March 1922).

[728] RBA, UNI / SU / AS / 2 / 1 / 39, *Higher Education in Mining*, p. 1.

[729] RBA, UNI / SU / AS / 2 / 1 / 39, *Higher Education in Mining*, p. 1.

[730] Williams, p. 263. Mr. Justice Sankey Coal Industry Commission Act, 1918, Interim Report

[731] RBA, UNI / SU / AS / 2 / 1 / 39, *Department of Higher Education in Mining,* pp. 11-12.

[732] Williams, pp. 262-63.

geography needed to be incorporated onto the curriculum.[733] By the institution's second session a course of Geography lectures and practical work during the Christmas and Lent terms had been arranged for Saturday mornings in the department of Geology.[734] These proved popular and by 1926 there was an increasing demand by students who were studying geology for further courses in geography.[735] An application by the college to establish a department for Geography was denied by the University Senate. The Welsh university considered the application an 'unnecessary duplication', due to the existence of a geography department at Aberystwyth University College.[736] An honours degree course in geography was established at Aberystwyth in 1918, with the appointment of Herbert J. Fleure (1877-1969) as its head of department.[737] Although officially titled 'the Gregynog Chair of Geography and Anthropology', Fleure made it clear that the two disciplines would be studied together as human geography.[738] Aberystwyth University College became the first institution in Britain to offer undergraduate and postgraduate studies in geography in both the Faculties of Arts and Science. [739] However, the development of geographical studies at the Swansea institution did not end with the failure to establish a department during this period, and the progress of the discipline of geography is discussed in the next chapter.

These early departmental development setbacks did not hinder the creation of inter - college relationships. The same year the application to establish a department of Geography was turned down, an important inter-college initiative between the departments of Botany and Zoology at the colleges of Cardiff and Swansea was created.[740] The scheme involved providing laboratory facilities off campus, by jointly renting a small cottage 'Kiawarra' at Port Eynon. The cottage provided accommodation and a field laboratory so that staff and students could stay for an extended period to undertake biological research of the area.[741] This arrangement continued until the

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[733] Emrys George Bowen, 'Geography in the University of Wales, 1918-1948' in *British Geography 1918-1945*, ed. by Robert W. Steel (Cambridge: Cambridge University Press, 1987), p. 38.
[734] Richard Burton Archives, Swansea University, reference no: LAC / 115 / 2, *Council Senate Minutes* (17 October 1921), p. 7.
[735] RBA, reference no: UNI / SU / AS / 2 / 1 / 91, Report concerning the needs and projects of the College, p. 9.
[736] RBA, UNI / SU / AS / 2 / 1 / 91, *Needs and Projects of the College*, p. 9.
[737] Bowen, pp. 28-9.
[738] The chair was named this in recognition of the Misses Davies of Gregynog who donated £20,000 to the college to support areas of study and research in international affairs.
[739] Bowen, p. 29.
[740]Richard Burton Archives, reference no: UNI / SU / AS / 2 / 1 / 91, *Report on Biology Department* (1926).
[741] RBA, UNI / SU / AS / 2 / 1 / 91, *Biology Department*.

cottage was put up for sale in 1929.[742] Dr Florence Mockeridge, head of the biology department informed the college Council that biological field research in the area was still able to continue due to the generosity of the Great Railway Company. Herbert Morgan of the railway company agreed that the college could use a large room and accommodation in the lighthouse at Mumbles Head for an annual rent of 5/-. This arrangement was on the condition that the college would finance the essential repairs that were needed to make the room safe to work in.[743] Once fitted out the facility would continue to be an important research resource for a department which would continue throughout the decades to have inadequate space.[744]

While Mockeridge's initiative at Port Eynon was an unusual and complex inter-collegiate scheme within the federal system of the University of Wales during this period, it was not the only connection between the constituent colleges. Due to the federal bureaucracy that connected the colleges it allowed the exchange of teaching staff within the system. The scheme 'interchange of teachers within the university' was created and became popular with staff and students alike.[745] By 1930 the scientists at the science faculty at the University College of Swansea were taking advantage of this scheme with visits by scientists of the constituent colleges visiting and lecturing at the Swansea institution and vice-versa. The scheme did not just benefit university students. In connection with the remit of the scheme a staff member from the Metallurgy department, Mr. Keeping delivered a serious of lectures to senior students from secondary schools on 'The New Quantum Wave Mechanics'.[746]

During the first decade of the Swansea institution's development the building of connections between the institution and the town was deemed to be a practical necessity. As the problem of providing accommodation for staff members and both male and female students problems demanded the immediate attention of the university's administration.[747] Solving the problem of accommodation was taken up enthusiastically by the residents of Swansea, and this was a clear demonstration of the early relationship between the town and its new institution. This support is well-documented in the institution's archive of the registrar's correspondence, which reveal

[742] RBA, Annual Reports 1929 – 1932, *9th Annual Report*, p. 14.
[743] RBA, *9th Annual Reports*, p. 14.
[744] RBA, *11th Annual Report*, p. 17.
[745] Richard Burton Archives, reference no: Annual Reports 1929-1932, *9th Annual Report of Council to the Court of Governors* (uncatalogued) p. 18.
[746] RBA, reference no: *9th Annual Report*, p. 18.
[747] Dykes, pp. 102-04.

written communication from local churches and chapels who organised committees to place students and staff in suitable lodgings. In addition, the archive contains letters from townspeople who wished to offer paid accommodation in their homes.[748] This correspondence reveals the significant amount of engagement the university college had with the town during its early period. However, as most of the early interconnections between the institute and the town was limited to service engagements the necessity of widening educational links with the town on different levels was highlighted by Viscount Richard Haldane in an address delivered at Swansea on 26 November 1921, who suggested that:

> Be earnest about the national character of your university – go beyond the wall of the colleges, and out among the people establishing schools in the mining districts and in the industrial regions.[749]

While a two-week scientific summer school was held on the university college grounds in 1922 in which lectures and practical courses were given in the disciplines of physics, chemistry, geology and botany, the institution had started to engage with local schools.[750] A part was played in this external development by departmental scientific societies. The Biology Society recognised the importance of establishing links with secondary schools and by 1926 visits to local secondary schools were established.[751]

In the university college's second academic session in moves to engage with the town on an informal level, a series of public lectures was arranged during the winter months at the Swansea Young Men's Christian Association (Y.M.C.A). by members of the university college staff including scientists from the science faculty.[752] The public also had access to certain science lectures held at the university college campus, as illustrated by the series of three lectures, 'Bacteria as Friends and Foes' given by the head of the biology department, Dr Mockeridge.[753] The arrangement of public lectures continued during the institution's first decade, but the implementation of public courses became formalised at a meeting in February 1923 between representatives of the

[748] RBA, UNI /SU /AS /2 /1 /19, *Registrar's Meetings*.
[749] Swansea University Library Pamphlets, Box no: W / LD – W / LF1145, reference no: W / LF 1145, Viscount Haldane, *The University and the Welsh Democracy* (Oxford: Oxford University Press, 1922), p. 20.
[750] Richard Burton Archives, reference no: UNI / SU / AS / 4 / 1 / 1 / 3, Senate Minutes 1922-23, *Committee of Senate* (12 July 1923), p. 98.
[751] Richard Burton Archives, reference no. Annual Reports 1925-1928, *6th Annual Report of the Council to the Court of Governors*, p. 14.
[752] RBA, UNI / SU / ACM / AS / 4 / 1 / 1 / 3, *Senate Minutes 1922-23* (25 September 1922), p. 4.
[753] RBA, reference no: *4th Annual Report*, p. 9.

Management Committee of the Coal Owners' University Trust Fund and the Senate of the university college, when ambitious plans were proposed for the extension of public engagement at population centres across the region.[754] Yet, while the Senate was in general agreement with financing the scheme of providing courses of lectures at different locations, its representatives were wary of the high travelling costs to outlying areas. Consequently, series of short courses of lectures including the disciplines of geology and geography were provided at outlying places including Ammanford, Brynamman and Ystalfera, with further potential courses being managed by the University Extension Lectures Committee.[755]

Conclusion

The appointment of the institution's first principal, Franklin Sibly was an advantageous move by the newly established University College of Swansea, as the principal's vision and high expectations for the institution defined the ambitions of its early history. These aspirations were reinforced by the appointment of high calibre scientists as the key members of staff of the science faculty who played an intrinsic part of the successful establishment of their departments. Furthermore, Sibly's managerial style of flexibility and approachability enabled his senior staff to direct and shape teaching and research in their own departments and ensured that the university college's move from its temporary residence to its permanent residence at the site of Singleton Abbey was successful. These scientists initially created an environment of co-operation and community by sharing laboratory and research facilities with the staff at the Technical School. While addressing the practical difficulties of teaching students in exacting circumstances and limited space, the heads of departments and their limited numbers of staff cultivated internal departmental communities and inter-departmental relationships. However, forming staff relationships was made easier as individual scientists had previous experiences of working with each other.

The opening in 1923 of the 'temporary' science buildings at Singleton consolidated not only the creation of the science faculty, but it also symbolised the establishment of the Singleton Campus of the University College of Swansea. To ensure successful completion of the project the staff from the university college and local government

[754] RBA, UNI / SU / ACM / AS / 4 / 1 / 1 / 3, *Senate Minutes 1922-23*, (12 February 1923).
[755] RBA, UNI / SU / ACM / AS / 4 / 1 / 1 / 3, *Senate Minutes* (16 May 1923 and 29 May 1923).

collaborated to ensure the buildings and their facilities were designed to fulfil the aspirations of the different science disciplines. Furthermore, the buildings completion was a visible sign to the industrial community that the institution was progressing. Significantly, the completion put an end to the political and financial tensions that were generated during the building's planning and early stage. However, while the success and growth of the different disciplines within the science faculty would eventually put pressure on these facilities, the university college was innovative in providing teaching and research spaces despite the financial and political pressures of the period.

Historic connections which had been cultivated by members of the Swansea University movement and local industrialists became the base of vital systematic financial support for the institution during its early difficult years and grew into a network of industrial funding for fitting out and equipping science laboratories and materials for scientific research. As the science faculty became established this generosity was reciprocated by the creation and direction of scientific research projects that dealt with specific problems of local industry, particularly the tinplate and steel industries. The growth of academic and industrial connections was a fundamental development and it was this inter-reliance that shaped the direction of early research projects. The subsequent publication of scientific research a such an early and challenging time in the university college's history is an accomplishment and a consequence of the abilities of the senior staff.

Industrial networks were further strengthened with individual science departments by formalising the relationships with the creation of a university-based advisory committee, which cultivated co-operation and facilitated student and staff visits to industrial works. Furthermore, the involvement of staff such as Edwards in the extra-mural activities of local industry, notably the local branches of national industrial societies and organisations promoted a closer understanding between academia and industry. Yet, the science faculty did not just confine its connections to industry, the successful establishment of links with various institutions including the National Museum of Wales and the Royal Gardens at Kew by staff at the Geology and Biology departments provided a supply of varied specimens for teaching and research. Throughout the institution's first decade the numbers of Geological and Botanical specimens that were donated from institutions and individuals was such that a college museum was established.

The University College of Swansea's success in consolidating the science disciplines of chemistry, geology, physics, metallurgy and biology into a functioning teaching and research faculty is apparent from departmental growth, but there were limitations to that expansion. As the newest member of an established federal system the institution had to compromise. A situation which was illustrated by the reversal of Swansea institution's plans for curriculum expansion in Mining and Geology in deference to the established departments or prior departmental plans of the older constituent colleges. Sibly's diplomatic leadership ensured that any scientific curriculum setbacks did not hinder the development of inter-colligate initiatives and relationships. Finally, a recognition of the limitation of the university college's contacts with the wider community of the town initiated educational initiatives, of which the science departments played a key part.

Chapter Four – Development, Stagnation and War, 1930 - 1945

Introduction

A decade after its establishment, the science faculty at the University College of Swansea had worked through its early difficult years of financial struggle and had established a nationally and internationally recognised scientific community at the institution. However, the 1930s witnessed serious internal departmental pressures which presented a threat to future departmental developments. The chapter focuses on the causes that created the internal discord within the science faculty and argues that it was a failure to develop a long-term strategy for academic development which created these later issues. Departmental problems were further exacerbated by the loss of academic staff working across the spectrum of scientific disciplines. While asserting that the cohesive nature of the individual departments of the science faculty deflected any major disruptions caused by staff resignations, this section argues that the failure to increase the numbers of permanent teaching and laboratory employees was a dereliction by the university college authorities. Furthermore, an analysis of the Registrar's correspondence reveals that the senate decisions regarding the appointment of staff and the implementation of major curriculum developments affected the availability of departmental teaching and research space. Thereby, the chapter contends that yet again the provision of adequate laboratory, research space, and facilities became an urgent issue and assesses the consequences, as well as the responses by departmental heads in addressing this problem.

While the 1930s saw a renewal of earlier challenges for the science faculty, there were other difficulties which were the consequence of an adverse financial global climate. The chapter will investigate how the University of Wales had to limit its expenditure which had a crucial effect of checking the University College of Swansea's plans for expansion. Yet, while taking a cautious path with its budget, the college was under pressure to increase its staff salaries, and especially the salaries of the non-professional staff. Moreover, the chapter argues that it was the continuing ethos of community that initiated action by departmental heads to support better conditions for the lower paid staff. In addition, the salaries of the institution's staff are assessed in the context of wider national concerns for universities and higher education. One consequence of this period of recession was the high rate of unemployment, and this section critically evaluates how high unemployment rates among young people had a direct bearing on student numbers. Furthermore, this section asserts that concerns regarding student poverty and graduate unemployment, as well as unemployment in the wider public encouraged the university college to act and establish new community initiatives.

The university college's second decade ended with the outbreak of World War II. The final part of this chapter critically engages with the consequences that the conflict had on academic science at the Swansea institution. While noting how the passing of the Emergency Powers Act of 1939 disrupted the daily running of the university institution, this section briefly examines the growth of collaborative scientific research between academia, industry, and the military during the war years.[756] How this related to the science faculty at the Swansea institution is discussed through the occupation of the Armaments Research Department of the Woolwich Arsenal at the science faculty. Additionally, the chapter asserts that the authority of the post of the departmental head of the science faculty was undermined to an external authority to enable the deliverance of scientific wartime research. The concluding section argues that while the community of the science faculty was compromised by a lengthy period of instability, it was successful in continuing with the provision of teaching and research to its students and its visiting evacuees.

Departmental Staff Changes and Internal Pressures

In 1930 the University College of Swansea entered its second decade of delivering higher education, and the institution's science faculty was a key part of that educational service offering degree and honours degree courses in both the applied and practical science disciplines.[757] Yet, once the departments of biology, chemistry, geology and physics and metallurgy were established there was little internal departmental development in relation to increasing teaching and research staff. By 1930 the science faculty entered a period of stagnation, which put continuous pressure on departmental staff as there was a steady increase in students across the science disciplines throughout the 1920s.[758] The problem of staff shortages was further exacerbated during the early

[756] W. Ivor Jennings, Local Authorities in War-Time, 2nd ed (London: Charles Knight & Co., Ltd., 1942), pp. 69-71.
[757] Dykes, p. 124.
[758] Richard Burton Archives, Swansea University, Annual Reports 1929-1932, *Tenth Annual Report of Council to the Court of Governors* (1930), p. 32.

1930s, as long serving members of the departments of the science faculty left the institution to pursue their careers in academia and industry. There were few opportunities for career advancements for many scientists who stayed within academia, especially in senior professorial vacancies.[759] These limited career opportunities encouraged movement as individuals tried to advance their own careers.[760] At Swansea there had been the usual and expected departures of junior staff during the first decade of the college. One example was Norman Allen (1903-1972) who joined the Metallurgy department in 1925 as a researcher for the British Non-Ferrous Metals Research Association and left after three years.[761] Allen was researching the porosity of copper and copper alloys, and continued the research at his next post as an Assistant Lecturer at Birmingham University. It is alleged by Sir Charles Sykes, the writer of Allen's biographical memoirs, that the scientist left Swansea university college for an improvement in his financial circumstances.[762]

Such resignations were expected as there is evidence of junior staff leaving their first positions to take up career and research opportunities at other institutions or within industry. This is certainly the pattern of the early careers of numerous science teachers and researchers who graduated from Swansea during the institution's first decade, as their early work histories clearly depict transient work patterns.[763] Additionally, increasing numbers of graduates from the science faculty were successful in achieving positions away from the traditional career paths of academia and local industry.[764] Between 1922 and 1929 Swansea science graduates in chemistry, physics and metallurgy were choosing government research laboratories and overseas posts to establish their careers in, a development which is illustrated in the table below.

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[759] Matti Klinge, 'Teachers' in *A History of the University in Europe Vol III* ed. by Walter Rüegg (Cambridge: Cambridge University Press, 2004), 123-162 (p.114).
[760] Klinge, p. 114.
[761] Sir Charles Sykes, 'Norman Percy Allen, 1903-1972' in *Biographical Memoirs of Fellows of the Royal Society* vol. 19 (1973), 1-18 http://rsbm.royalsocietypublishing.org/subscriptions [accessed 07 June 2018], p. 3. Allen's research was published in a series of papers between 1929-1933. Allen's research into problems associated with copper refining was considered by metallurgists to be pioneering in a complex field and important to industry.
[762] Sykes, p. 3.
[763] Richard Burton Archives, reference no: UNI / SU / AS / 2 / 1 / 130, *Teaching Posts held by Past Students 1922-1929.*
[764] RBA / UNI / SU / AS / 2 / 1 / 130.

Figure 4: Teaching Posts held by Past Students from the University College, Swansea, 1929.

Department	Gov. Lab.	Industry	Research Dept.	Academic Post	Overseas Post
Chemistry	3	8	1	3	0
Metallurgy	5	26	0	7	10
Physics	0	3	0	5	1

Reference no: Richard Burton Archives, UNI / SU / AS / 2 / 1 / 130

A further breakdown of the overseas posts taken by Metallurgy graduates note that the appointments were from across the British Empire, in countries like Australia, Burma and Singapore as well as in the United States, Japan and Spain.[765]

Another reason for the departure of junior staff from the science faculty was the lack of opportunity for career developments within small departments, which was partly due to the lack of a compulsory retiring age.[766] Consequently, this meant that many 'junior' staff were senior in age. However, in young institutions like the University College of Swansea departmental growth presented career opportunities for junior teaching and research staff.[767] The departure of a senior member of staff could offer the opportunity for a career progression for junior staff, as illustrated by the promotion of Leonard Bessemer Pfeil (1898-1969) to senior lecturer in the Metallurgy department.[768] Pfeil's internal departmental promotion was made possible due to the resignation of Dr Norbury, who left the department in 1927 for the post as Chief Research Metallurgist to the British Cast Iron Research Association at Birmingham.[769] Yet, Pfeil's departure from the institution three years later also revealed how the loss of a senior member of staff had implications for the entire department. This was especially relevant when a staff member such as Pfeil had been involved in the development of the department since the science faculty's earliest years.[770]

[765] RBA / UNI / SU / AS / 2 / 1 / 130.

[766] Graeme C. Moodie and Rowland Eustace, *Power and Authority in British Universities* (London: George Allen & Unwin Ltd., 1974), p. 39.

[767] Moodie and Eustace, p. 39.

[768] RBA, Annual Reports 1925-1928, *Seventh Annual Report of Council to the Court of Governors* (1927), p. 41.

[769] RBA, *Seventh Annual Report*, p. 41.

[770] N.P. Allen, 'Leonard Bessemer Pfeil, 1898-1969' *in Biographical Memoirs of Fellows of the Royal Society* vol.18 (1972), 476-487 http://rsbm.royalsocietypublishing.org/subscriptions [accessed 7 June 2018], p. 478.

Pfeil was highly regarded and considered an adaptable and conscientious member of the staff of the Metallurgy department. The lecturer's scope and adaptability in his role ensured that Pfeil undertook a full lecturing timetable as well as preparing laboratory testing, notably the hundreds of research test samples of single crystals of iron.[771] These test samples were needed for the purpose of investigating the nature of Neumann Lamellae and the conditions needed for their formation in iron and steel.[772] This industrial research was funded by the Carnegie Scholarship fund of the Iron and Steel Institute, and the significance of Pfeil's project established his reputation for undertaking high quality research.[773] Like his predecessor, Pfeil transferred his skills from academia to industry, obtaining the appointment as the Senior Research Metallurgist in the laboratories of the Mond Nickel Company in Birmingham.[774] Dr Robert Higgens (d. 1983) from the Royal Technical College, Glasgow succeeded Pfeil as senior lecturer.[775]

Pfeil's departure highlighted the ongoing situation that had defined the structure of the workload of senior staff in the Metallurgy department for four years. A situation which was created in 1926 when Professor Sibly resigned, and the head of the Metallurgy department Professor Edwards added the complex duties of the Principalship of the college to his own.[776] As Vice-Principal it was natural that Edwards would step into the role of principal until there was a new appointment, but what is not clear is why Edwards was still balancing the dual roles of head of department and principal four years later. The decision might have been one of convenience for the college, as a favourite contender for the position, Thomas Jones (1870-1955) had declined the offer of the principalship.[777] Edwards was as reluctant to accept the

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[771] Allen, p. 478.

[772] RBA, Annual Reports 1924-1925, *Fifth Annual Report of Council to the Court of Governors* (1925), p.33. Neumann Lamellae are 'straight, narrow bands appearing in the microstructure parallel to the crystallographic planes in the crystals of metals that have been deformed by sudden impact' – Science Dictionary.

[773] RBA, Annual Reports 1925-1928, *Sixth Annual Report of Council to the Court of Governors* (1926), p. 39, Annual Reports 1929-1932, *Tenth Annual Report of Council to the Court of Governors* (1930), p. 41.

[774] RBA, *Tenth Annual Report*, p. 41.

[775] RBA, Annual Reports 1929-1932, *Tenth Annual Report* (1930), p. 41. Dykes, p. 111.

[776] Leonard Bessemer Pfeil, 'Charles Alfred Edwards, 1882-1960' in *Biographical Memoirs of Fellows of the Royal Society* vol. 6 (1960), 32-38 http://www.jstor.org/stable/769332 [accessed 13 March 2018), p. 35.

[777] Benjamin Bowen Thomas, Jones, 'Thomas (1870-1955), university professor, civil servant, administrator, author;' in *Dictionary of Welsh Biography* (2001), http://yba.llgc.org.uk [accessed 13 June 2018. J. Gwynn Williams, *The University of Wales 1839-1939* (Cardiff: University of Wales Press, 1997), p. 256.

position of principal as he had been when was originally offered the position in 1920.[778] Edwards' refusal of the principalship in 1920 was due to his preference for the professorship of the Metallurgy department and the opportunity to build up a Metallurgy department. Thereby, this role was one that he wished to keep when he later agreed to take on the responsibilities of principal.[779] However, the Court of Governors decided that due to the responsibilities of his principalship, Edwards role as head of department would be reduced to supervising student's work and directing research in the department.[780]

In his obituary for Edwards, Pfeil confirms that Edwards's added responsibilities reduced his presence in the Metallurgy department.[781] The small community of the Metallurgy department would have felt the absence of Edwards, as he was instrumental in establishing the friendly atmosphere of the department. The highlight of which was his enthusiastic encouragement of students and colleagues to regularly join him for tea at 4pm in the Assay Laboratory. This departmental custom is remembered by Pfeil as, 'a 'free for all' with outrageous theories and explanations becoming tempered by argument and student problems resolved by free discussion'.[782] In fact taking afternoon tea in groups in the laboratory was not an unusual practise during this period, and would continue to be a regular practise in many academic laboratories up until the 1950s.[783] While the practise might be seen as of little importance, the animal Pathologist Professor Beveridge (1908-2006) suggests that the custom allowed an informal space for the valuable exchange of ideas and discussions.[784] However, what is clear is that Edwards's divided responsibilities affected the department, and the increasing administration and day to day duties of running an expanding department fell to the assistant professor Leonard Taverner.[785] Taverner continued with these responsibilities

[778] Dykes, p. 111.
[779] Williams, p. 255. Dykes, p. 111.
[780] RBA, UNI / SU / AS / 2 / 1 / 102- UNI / SU / AS / 2 / 1 / 104, file no: UNI / SU / AS / 2 / 1 / 104 reference no: H140.
[781] Pfeil, p. 35.
[782] Pfeil, p. 35.
[783] William Ian Beardmore Beveridge, *The Art of Scientific Investigation* (London: William Heinemann Ltd., 1950), p. 64.
[784] Beveridge, p. 64.
[785] Dykes, p. 111.

until 1940 when he resigned his post and took up the appointment of chair of Metallurgy at the University of Witwatersrand in South Africa.[786]

Other departments in the science faculty also lost longstanding key members of staff during the early 1930s, and these departures changed the dynamics of the individual departments. In 1930 the Geology Department lost Emily Dix who left the institution to further her career by taking up the appointment of Geology Lecturer at Bedford College, University of London.[787] While not a senior member of staff, Dix was given credit by the college for making the institution widely known due to her valuable research into Coal Measure Geology.[788] Also, through her research and fieldwork Dix established strong connections between the college and the local coal industry, with the mining engineers appreciation of her research being well known.[789] As explained by Woodward, the second referee in her application to Bedford College, 'It would be impossible for me to adequately indicate how much they appreciate what she has done, or how much they admire her character'.[790]

Three years later the department lost its founder and head of department Professor Trueman, who left the college to take up his appointment as the Chaning Wills Professor of Geology in the University of Bristol.[791] This appointment also gave Trueman an added career opportunity, as he was also given the position as Dean of the Faculty of Science at the university.[792] Trueman's leaving comments regarding his staff and students at Swansea give an indication of the sense of community that had developed within the Geology Department.[793] He notes the enthusiasm and co-operation of both staff and students stating, 'Few Geology Departments have had a more brilliant body of research students, none has had a more loyal group'.[794] The staff of the small Geology Department had been working alongside Trueman for many years, with M.

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[786] J. H. Potgieter, 'The School of Chemical and Metallurgical Engineering at the University of the Witwatersrand' in *The Journal of the South African Institute of Mining and Metallurgy* (2015), www.scielo.org.za [accessed 15 June 2018].
[787] RBA, Annual Reports 1929-1932, *Tenth Annual Report* (1930), p. 32.
[788] RBA, *Tenth Annual Report*, p. 32.
[789] Cynthia V. Burek and Christopher J. Cleal, 'The Life and Work of Emily Dix (1904-1972)', *in Geological Society, London, Special Publications* vol. 241 (2005), 181-196 (p. 181).
[790] Burek and Cleal, p. 181.
[791] W. J. Pugh, 'Arthur Elijah Trueman, 1894-1956', in *Biographical Memoirs of Fellows of the Royal Society*, 4 (1958), 291-305 http://rsbm.royalsocietypublishing.org [accessed 23 October 2017], p. 293.
[792] Pugh, p. 293.
[793] RBA, Annual Reports 1933-1935, *Tenth Annual Report* (1930) p. 32. Annual Reports of Council to Court of Governors 1933-1935, *Thirteenth Annual Report* (1930), p. 41.
[794] RBA, Annual Reports 1933-1935, *Thirteenth Annual Report* (1933), p. 40.

Marchant the laboratory attendant since the department's foundation, and Alan Stuart the assistant lecturer for twelve years.[795]

The departure of Trueman was not only a loss to the department but also to the college, as he had not only been responsible for creating the Geology department but had been influential in the development of the college curriculum.[796] The introduction and development of geography as a discipline at the university college was the result of the efforts of Trueman who initially established extra-mural classes in a Geography Certificate course on Saturday mornings.[797] While the discipline of geology was Trueman's area of expertise, he had also researched and written papers on geographical subjects which included 'Population changes in the eastern part of the South Wales coalfield', *Geography. Journal* (1919) and 'The iron industry of South Wales', *Geography Teacher* (1921).[798] The increasing popularity of the discipline encouraged an expansion in its teaching at the Swansea institution, with a degree course in geography established in 1929 and the later development of a Final Degree courses authorised in 1931.[799] Trueman was appointed Professor of Geology in 1930, and in recognition of the developments that had been undertaken was made head of the Department of Geography.[800] The successor to Truman had no problems familiarising himself with the University College of Swansea, as he had strong connections with the College as well as the area. The newly appointed Professor of Geology and Head of the Department of Geology and Geography, Thomas Neville George (1904-1980) was born in Morriston, Swansea and educated in the area.[801]

The desirability of awarding scholarships to enable financially disadvantaged young people to undertake a university education was apparent in the case of George. A recipient of the Oxford Senior Certificate the highly talented George studied at the sixth-form Swansea Grammar School.[802] As a result of being unable to afford another

795 RBA, *Thirteenth Annual Report,* p. 40.
796 Pugh, p. 293.
797 Pugh, p. 293.
798 Emrys George Bowen, 'Geography in the University of Wales, 1918-1948' in *British Geography 1918-1945,* ed. by Robert W. Steel (Cambridge: Cambridge University Press, 1987), 25-44 (p. 38). Pugh, p. 302.
799 Pugh, p. 293. RBA, Annual Reports 1929-1932, *Eleventh Annual Report* (1931), p. 34.
800 Pugh, p. 293.
801 Mary Auronwy James, 'George, Thomas Neville (1904-1980), Professor of Geology' in *Dictionary of Welsh Biography* (2012), [accessed 29 May 2018].
802 Bernard E. Leake, 'Thomas Neville George, 13 May 1904-18 June 1980' in *Biographical Memoirs of Fellows of the Royal Society,* vol. 37 (1991), 198-217 http://rsbm.royalsocietypublishing.org/subscriptiondafs [accessed 29 May 2018], pp. 119-200.

year at the fee paying school George was able to enter the newly established University College, Swansea in 1920 due to the provision of a local scholarships made available to young people whose families had financial hardships. Further financial support after graduating with a first-class Honours degree in geology enabled George to undertake post-graduate studies obtaining a M.Sc. in 1925. The financial support came in the manner of a studentship, and a university postgraduate award supported him during his post-doctoral research at Cambridge University.[803] As part of a very small department the research interests of his supervisor, Trueman as well as Principal Sibly guided the honours student towards studying the stratigraphy of the carboniferous limestone of the South Wales coalfield and the Gower. It was not unusual for lecturers to have an influence on the direction of research undertaken by their students, as the evidence of sociological studies of scientists by Stephen Cotgrove and Steven Box demonstrated.[804]

The empirical data collected by Cotgrove and Box suggests that the professional identity and reputation of a scientist was sometimes the attraction that steered a student to a particular area of research.[805] However, Bernard Leake's suggests in his detailed biography of George that the research topics and practises that were an influence on George had connections back to the influential geologist Swinnerton, stating that 'there is a clear thread of derived direction from Swinnerton to Neville George'.[806] After graduating from Cambridge with a PhD George returned for a brief spell to Swansea University College as a part-time Research-Demonstrator in geology.[807] Prior to his appointment as Chair of Geology George worked for three years as a geologist in HM Geological Survey, combining field research and indoor work at the Museum of Practical Geology.[808] Varied practical experience combined with his extensive publications and backing from four Fellows of the Royal Society, as well as from Sibly, confirmed George's appointment to the post of Head of department.[809]

However, George's familiarity with the college had its drawbacks. There was a stressful element to occupying a senior position in the faculty for George, as most of his colleagues across the science faculty had previously been his teachers.[810] Consequently,

[803] Leake, pp. 119-200.
[804] Cotgrove and Box, pp. 47-8.
[805] Cotgrove and Box, p. 47.
[806] Leake, pp. 200-201.
[807] James.
[808] Leake, pp. 203-4.
[809] Leake, pp. 203-4.
[810] Leake, pp. 203-4.

the perceived awkwardness of the situation affected George's interaction with his colleagues on a social level, and he rarely attended the department's social gatherings. On a professional level George organised the Geology department in an informal way preferring casual discussions to formal staff meetings. Apart from his teaching commitments George spent considerably less time in the department than his predecessor, preferring to delegate to his other members of staff. As discussing and conducting research was his preferred environment, George became well known for inviting small groups of his research students to his home on the Gower.[811]

Addressing the serious problems of limited staff and departmental space continued to be priorities for George. At the beginning of the 1931 academic session Trueman had informed the college authorities, that due to increasing student numbers the Geology department was finding it difficult to organise teaching with the existing staff numbers.[812] The teaching duties were extensive with six or more teaching hours undertaken in both geology and geography each day.[813] Staff were also expected to conduct field excursions during some weekends, as well as arranging and participating in a long annual Easter trip to conduct field research at different sites in Wales as well as in England and the Irish Free State.[814] The Council responded to the problem by appointing Mr. J. S. Turner as a part-time assistant to the newly-appointed assistant lecturer Brian Simpson, although it was only a temporary post.[815] During the years before the war Simpson mainly taught the areas of stratigraphy and palaeontology.[816] Further support for the department was given in the establishment of a permanent post of lecturer of Geography, which was a positive move towards meeting the needs of those students wishing to study the newly established degree subject.[817] D. Trevor Williams, former student at Aberystwyth University College was appointed to the post.[818] Williams had published work in the field of his specialist interest of historical geography, and this work was used to develop the structure of geographical studies at the Swansea college.[819]

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[811] Leake, pp. 205-6.
[812] RBA, Annual Reports 1929-1932, *Eleventh Annual Report* (1931), p. 34.
[813] Leake, p. 206.
[814] Leake, p. 206.
[815] RBA, *Eleventh Annual Report*, p. 34.
[816] Derek Ager, *Three Score Years and Ten of Geology at Swansea* (1989, unpublished), p. 3.
[817] Bowen, p. 38.
[818] Bowen, p. 38.
[819] RBA, Annual Reports 1929-1932, *Eleventh Annual Report* (1931), p. 34.

The appointment of a specialist in geography and the use of a special grant to purchase laboratory apparatus and materials to establish a geographical library conferred credibility to the Geography department.[820] Such developments led to a later recognition within the national geologists community that both Trueman and George had played a significant role in establishing geography as a university discipline.[821] However, when in 1933 George was appointed head of the Geology and Geography departments, the demands on staff had become acute and were further exacerbated by the continuing success of the Geography department. Subsequently by the following academic session having just one member of staff (Williams) responsible for the teaching and practical responsibilities had become untenable.[822] The other science departments were established but still very limited in staff numbers, and this would have consequences when unexpected situations occurred. Such as during the 1936 session when the Chemistry department experienced a situation when both Professor Coates and Dr Hinkel were absent for a period of weeks due to ill health.[823] In his acknowledgement of the extra burden put on his staff by his absence Coates applauded their loyalties to the department, and by doing so highlights a developed community.[824]

There is evidence from the university archives that early in its development the science faculty established a system of appointing student demonstrators as extra help with laboratory teaching at the intermediate level.[825] Not only did these students assist with practical work in the laboratory, a few of them also gave short lecture courses.[826] At the beginning of the 1930s the system expanded to employing student demonstrators as the cheaper option to employing a fully qualified member of staff, as was the case with the Physics department in 1932.[827] Whilst declaring that the department urgently needed an additional staff member, Professor Evans stated in a letter to the Registrar, Edwin Drew that he was prepared to accept two student demonstrators. However, Evans did acknowledge the competency of student demonstrators, by stating that by employing them would add to the efficiency of the department. Yet, evident in the letter

[820] RBA, *Eleventh Annual Report*, p. 34.
[821] J. A. Steers, 'Physical Geography in the Universities, 1918-1945', in *British Geography 1918-1945* ed. by Robert W. Steel (Cambridge: Cambridge University Press, 1987), pp. 144-45.
[822] RBA, Annual Reports 1929-1932, *Fourteenth Annual Report* (1934), p. 43.
[823] RBA, Annual Report 1933-1935, *Sixteenth Annual Report* (1936), p. 18.
[824] RBA, *Sixteenth Annual Report*, p. 18.
[825] RBA, ref. no: UNI / SU / AS / 2 / 1 / 172, *Statement on Laboratory Teaching in Chemistry with special reference to Student Demonstrators*, (11 October 1933), p. 2.
[826] RBA, *Sixteenth Annual Report*, p. 13 and 18.
[827] RBA, File no: UNI / SU / AS / 2 / 1 / 153, *Letter to the Registrar, E. Drew*.

are Evans' feelings of frustration regarding the lack of progress in improving staffing conditions at the University College of Swansea, pointing out that he had worked with a better staff ratio to students during his previous post at Manchester University.[828]

Three years later Professor Mockeridge employed a similar tactic as the one Evans used when requesting extra staff, except on this occasion Mockeridge compared staffing levels in the Swansea Biology department to the corresponding departments in the other colleges within the Welsh federal system.[829] In her letter of 1935 to the Registrar Mockeridge claims that the Swansea department was under-staffed compared to: three fulltime assistants employed in the Botany department at Cardiff College, three fulltime assistants employed both at the Biology department at Aberystwyth and at Bangor Colleges. Mockeridge's dissatisfaction with the staffing levels at Swansea is revealed by her terse comment that she only had the 'equivalent of one assistant and two-thirds'. To add to the disparity between Swansea and her sister colleges, Mockeridge pointed out that Aberystwyth and Bangor had fewer students in their departments, with only seven Honours students at Aberystwyth compared to fifteen students studying at Swansea College.

Not all the departmental heads were happy with employing student demonstrators, as Professor Coates made clear with his comments in the Memorandum on Staffing of March 1934.[830] Coates stated that while he appreciated the value of student demonstrators he did not agree with the increasing practise of solving staff shortages by employing student demonstrators, instead of employing qualified university teachers. Coates argued that the practise of employing student demonstrator for laboratory work at the honours and research level was damaging to the quality of teaching due to their lack of experience and training, therefore they should only work with the intermediate level.[831] The importance of acquiring the skill of quantitative analysis was essential to inorganic chemistry and was achieved in the laboratory and needed the guidance of a qualified chemist.[832] Coates had expressed these opinions in an official capacity the year before, and concluded along with his colleagues from the other science

[828] RBA / UNI / SU / AS / 2 / 1 / 153.
[829] RBA, reference no: UNI / SU / AS / 2 / 1 / 198, Florence Mockeridge, *Letter to the Registrar, E. Drew* (29 March 1935).
[830] RBA, ref no: UNI / SU / AS / 2 / 1 / 188, *Memorandum on Staffing* (1 March 1934).
[831] RBA, ref no: UNI / SU / AS / 2 / 1 / 188.
[832] RBA, ref no: UNI /SU /AS / 2 / 1 / 172, *Statement on Laboratory Teaching*, p. 2.

departments that the increasing numbers of students at all levels was putting intense pressure on staff and departmental teaching and research space.[833]

The Continuing Problem of Departmental Space

The financial difficulties for higher education which had started in the 1920s became more focused during the 1930s, and universities had to curb expenditure.[834] The consequences of external financial pressures on the University of Wales was a limitation on expenditure for the constituent colleges, thereby checking Swansea University College's plans for expansion. While the Swansea institution had cleared the deficit on the building fund by 1932, there was still the need for economy on expenditure and an embargo on new developments was enforced.[835] Consequently, during the first half of the 1930s the heads of department including the new head of Geology, Professor George, had the unenviable task of dealing with the recurring problem of the lack of adequate departmental space. The Geology department as well as the Biology department had been given extra space in the main building, which had become available when the library, the Engineering Department and the departments of the Faculty of Arts moved into their new building during the session of 1925-26.[836] However, Trueman believed that this was a token offer of space, and that the 'ultimate needs of the department' would only be achieved if a building was specifically designed and built for the purposes of the department.[837]

The argument to the college authorities was that the Geology and the Biology departments deserved their own science block such as the ones used by the other departments in the science faculty. These views were supported by Dr Mockeridge head of the Biology department, though she expanded the suggested plans for a science block to a complete building which could accommodate further specializations of the Natural Sciences. In addition, both Trueman and Mockeridge believed that the provision of an adequate space for a Natural Science museum in a Natural Science building would be an

[833] RBA, Ref no: UNI / SU / AS / 2 / 1 / 172, pp. 2-3.
[834] Dykes, p. 112.
[835] Dykes, p. 114.
[836] Richard Burton Archives, Swansea University, Box no: UNI / SU / AS / 2 / 1 / 118 – UNI / SU / AS / 2 / 1 / 124, reference no: UNI / SU / AS / 2 / 1 / 120, file no. J12, reference no. J12, *Report of visit by University Grants Committee*, p. 3.
[837] RBA, file no: UNI / SU / AS / 2 / 1 / 79, reference no: F124, *Reports by Heads of Departments with reference to the future needs and projects of the College* (13 March 1925).

initiative which would benefit students and researchers alike.[838] Furthermore, the necessity of creating museum space to display the growing collection of botanical and zoological specimens was becoming urgent.[839] A one off 'generous' donation from the Trustees of the British Museum had to be kept in packing cases and cupboards due to the lack of accommodation. This collection of duplicates of sponges, polyzoa, crustacea, reptiles and amphibia, birds, mammals and 525 insects were extensive enough to form the nucleus of a zoological museum.[840] While Mockeridge needed the museum as a teaching and research facility for the department, she also suggested that the museum could be an amenity for the town with the public having access to the facility at allocated times.[841] Unfortunately, it would take another twenty-nine years for the college authorities to agree to undertake Mockeridge's vision of a new Natural Sciences Building, a project which she became deeply involved in at the planning stage of the new facilities.[842]

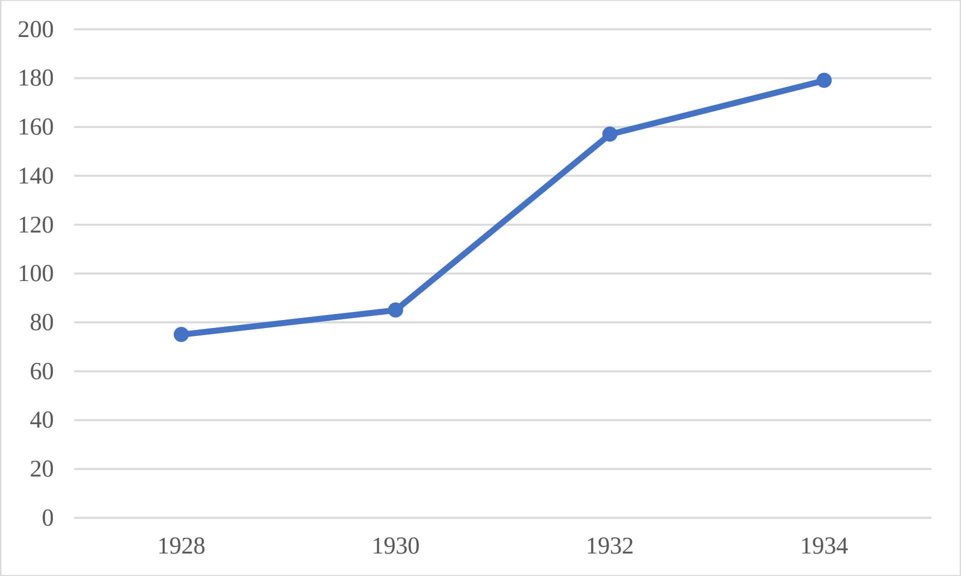
The creation of the natural sciences building project and its effect on departmental facilities will be analysed in Chapter 5. However, during the decades leading up to the opening of the natural sciences building, the provision of departmental space would be a constant problem for the heads of the Geology and Biology departments and their staff members. By 1931 the lack of adequate departmental space in the Biology department limited the ambitions of the department to extend degree schemes in zoology.[843] While it was agreed to offer a basic degree in zoology from the 1931/1932 session, it was impossible for natural sciences students to include zoology in their degree schemes. Furthermore, there were no plans to provide an Honours degree course as it was untenable to encourage further research students while the department's laboratory space and research accommodation was 'taxed to the upmost'.[844] Due to their role in planning and monitoring the internal strategies of the institution, the governors were warned by Mockeridge that the limitations of courses in zoology would have implications for future student numbers and gave evidence that this was already

[838] RBA, UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments with reference to the future needs and projects of the College* (13 March 1925).
[839] RBA, *Twelfth Annual Report*, p. 17.
[840] RBA, *Twelfth Annual Report*, p. 17.
[841] RBA, UNI / SU / AS / 2 / 1 / 79, *Twelfth Annual Report*, p. 17.
[842] H. E. Street, 'Professor Florence A. Mockeridge', in *Nature* vol. 183 (1959), http://www.nature.com/articles/183150aO.pdf. [accessed 18 June 2018], p. 150.
[843] Annual Reports 1929-1932, *Eleventh Annual Report* (Swansea: Ernest Davies & Sons, 1932), pp. 17-18.
[844] Eleventh Annual Report, p. 17.

occurring at the department. That evidence being that at the next session a student was transferring to another college where final modules in both zoology and botany were offered.[845]

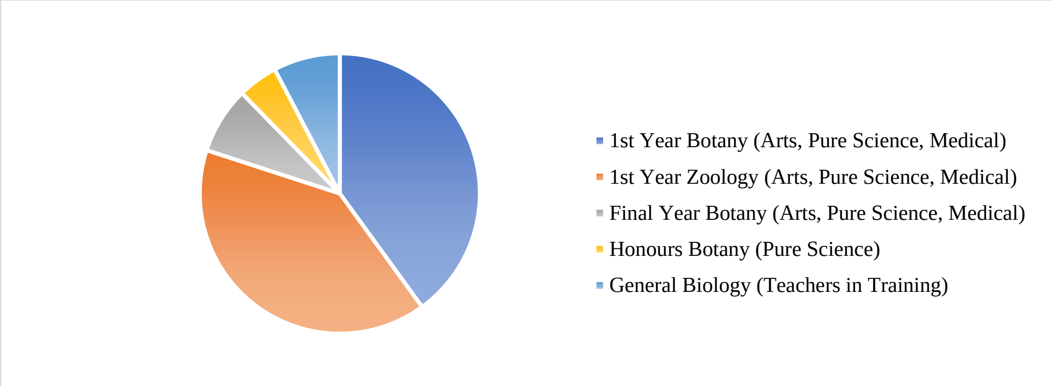
Yet, even with a restricted course in zoology, the entry of student numbers in biology for the 1932 session were greater than the previous sessions.[846] This is verified by the graph below which charts the increasing numbers of students studying Biology. Moreover, the pie chart gives a breakdown of the student numbers in relation to the specific area of their studies in the Biology department during the academic year 1929-1930.[847]

Figure 5: Biology Students at University College, Swansea, 1928-1934.



[845] RBA, *Eleventh Annual Report*, p. 18.
[846] RBA, *Twelfth Annual Report*, pp. 15-16.
[847] Annual Reports to the Council, *Eight to Fourteenth Reports*, 1928-1934.

Figure 6: Breakdown of Students studying Biology at University College, Swansea, 1931.



Reference: Richard Burton Archives, Annual Reports 1929-1932, *Eleventh Annual Report* (1931), p. 17.

The steady growth in students wishing to study biology at Swansea corresponded to the increasing numbers of students who qualified for the teaching profession, as well as the demand for Biology teachers.[848] In 1920 there was only one school in Wales teaching biology with the consequence that there was only one school entrant taking the C. W. B. examination compared to 1,860 entrants for botany. By 1929 there were sixteen schools teaching biology, and the numbers for the C. W. B. examinations reflected the growing interest in biology. The total entrants for biology had increased to 329 while numbers for botany had fallen to 1,104.[849]

In an effort to accommodate the increasing numbers of students in the limited teaching and laboratory space drastic measures were taken. It was decided to exclude the few honours students from the laboratory during certain periods each week, a situation which was not conducive to encouraging research in the department. [850] However, there was a further pressure on the departmental space as by 1932 student numbers in the Geology department had increased, with 95 students studying geology and 26 taking geography.[851] Unfortunately, the decision to accommodate all the students in the Geology department had a detrimental impact on the teaching and research space allocated to the Biology department.[852] Both these departments were based in the main building of Singleton Abbey and further available space was at a

[848] RBA, reference no: UNI / SU / AS / 2 / 1 / 137, *Memorandum on the position of Biology in the College* (1930).
[849] RBA, UNI / SU / AS / 2 / 1 / 137, *College Memorandum.*
[850] RBA, *Twelfth Annual Report*, p. 16.
[851] RBA, reference no: UNI / SU / AS / 2 / 1 / 152, *Report of the Committee concerning accommodation, especially in relation to the Departments of Geology and Geography and Biology* p. 1.
[852] RBA, *Twelfth Annual Report*, pp. 16-17.

premium.[853] The Biology department had use of a suite of three rooms which had a capacity for seating 42 students, and in addition two small laboratories which were acceptable for 36 students.[854] It was decided that laboratory space was paramount, so it was required that the departmental lecture room be converted into laboratory space. The decision to use this room illustrates the urgency in providing adequate departmental space, as this area was in a neglected state. It was under- used due to its position above the boiler room, and the inadequate ventilation gave no relief from the excessive heat and dust.[855]

To turn this space into a suitable working laboratory required not just reorganisation, but the installation of a sound-proofed floor and a working ventilation system.[856] Furthermore, the increase in student numbers continued with limited laboratory space for the individual student, so that by the 1934 session overcrowding had reached an unacceptable level.[857] To give some relief to students and staff, the wall between the two small laboratories was demolished to create another large laboratory space during the Christmas vacation. Creating another large space also helped ease staffing problems as larger classes could be held with one lecturer.[858] The allocation of teaching space was changed to the use of Lecture room no.1 on the ground floor of the main building of the campus. However, this was not ideal as the room was separated from the rest of the Biology department by some distance, which caused problems for staff when they had to carry equipment for use at lectures.[859] The rearrangement of the Biology department facilities did not resolve the problem of the cramped conditions of the one room that the three members of staff were allocated for their own work.[860] Positive working relations between staff members were further compromised by that fact that each member of staff was engaged in completely different lines of research in the same small area. Different areas of research required different equipment which increased the amount of scientific equipment needed in the research space, consequently reducing the available space further. Mockeridge noted that the issue of the allocation of

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[853] Dykes, p. 128.
[854] RBA, UNI / SU / AS / 2 / 1 / 152, *Committee concerning accommodation*, pp. 1-2.
[855] RBA, UNI / SU / AS / 2 / 1 / 152, *Committee concerning accommodation*, pp. 1-2.
[856] RBA, UNI / SU / AS / 2 / 1 / 152, *Committee concerning accommodation,* pp. 1-2.
[857] RBA, *Fourteenth Annual Report* (1934), p. 16.
[858] RBA, *Fourteenth Annual Report*, p. 16.
[859] RBA, *Twelfth Annual Report*, p. 16-17.
[860] RBA, Annual Reports 1935-1938, *Eighteenth Annual Report* (1938), p. 14.

space particularly affected the research students, as their individual research required different operations which ‘frequently caused mutual inconvenience’.[861]

In fact, the situation was so acute that Mockeridge stated that it was unwise to encourage students to undertake a post-graduate degree in the department while conditions were so inadequate.[862] The question of adequate research space during this period was not always confined to the availability of internal space. The lack of allocated outside research space gave the staff of the science faculty the opportunity to connect and build relationships with other local agencies. The lack of a botanical garden at the university meant that the Biology Department had to call on the resources of the Educational Gardens at Singleton Park. This gave which Mockeridge and her staff the opportunity to establish a working relationship with Daniel Bliss (1871-1939), the Superintendent of the Swansea Public Parks and his staff at the Singleton Educational Gardens.[863] As well as regularly providing botanical specimens for teaching purposes, Bliss arranged for a substantial area of greenhouse space to be made available to the Biology Department.[864] The procurement of greenhouse space was essential and allowed Dr Philip Gilbert Fothergill (1908-1967) the opportunity to continue his research into experimental cytology, an area of study that he began during his previous post at Newcastle.[865] Mockeridge further encouraged Fothergill in his research by ordering a particular microscope outfit to be used specifically by Fothergill in his line of cytological research.[866] Cytological techniques which are used in the study or manipulation of cells was a line of research that had not been previously been carried out in the department.[867] Therefore, Mockeridge felt this justified a grant from the university authorities to cover the cost of the equipment.[868] Later on in his career Fothergill would write a comprehensive history on aspects of evolution from the ancient

[861] RBA, *Eighteenth Annual Report* (1938), p. 14.
[862] RBA / UNI / SU / AS / 2 / 1 / 152, *Committee concerning accommodation*, p. 1.
[863] Ray Desmond, ed., *Dictionary of British and Irish Botanists and Horticulturalists* (London: The Natural History Museum, 1994), p. 80. RBA, *Thirteenth Annual Report* (1933), p. 18.
[864] RBA, *Seventeenth Annual Report* (1937), p. 14.
[865] Wikipedia, *Philip G. Fothergill* https://en.wikipedia.org/w/index.php?title=Phillip_G._Fothergill [accessed 27 July 2018]. RBA, *Seventeenth Annual Report* (1937), p. 14.
[866] RBA, UNI / SU / AS / 2 / 1 / 206, Florence Mockeridge, *Request for Grant for Laboratory equipment* (5 October 1936).
[867] Ralph, E. Cleland, ‘The Study of the Cell’, *American Journal of Botany*, 43. 10 (1956), pp. 870-881 (p. 872).
[868] RBA / UNI / SU / AS / 2 / 1 / 206, *Laboratory equipment.*

civilizations through to the modern period and the development of the relationship of evolution and genetics.[869]

Enlisting the help of outside individuals and agencies to further research at the department was a strategy that Mockeridge used on several occasions. In 1931 Mockeridge's discussions with the South Wales Sea Fisheries Committee resulted in the committee giving the Biology department access to its Patrol and Experimental Vessel the 'S.S. Feather'.[870] An arrangement that allowed the department to arrange cruises for marine research for second year students, thereby encouraging the development of the field of Marine Biology at the institution.[871] This was not the first agreement that Mockeridge had made with a marine facility. A few years previously an offer was made by Major Ronald of the Consolidated Steam Fishing & Ice Company, who gave the department the use of the trawler 'Clyne Castle' for a fortnight's trip to collect zoological specimens for teaching and research purposes.[872] The 'Clyne Castle' cruise and the later cruises were essential for the research project undertaken by Dr Little who conducted research on the effects of oil pollution on fish.[873]

The Biology and Geology departments were not the only departments of the science faculty to be affected by the lack of teaching and research space, as by the academic session of 1933-34 the Physics department was experiencing a shortage of space.[874] In comparison to the Biology and Geology departments which were situated in the main building, the departmental space allocated for the science departments in the specifically designed science buildings was generous. However, the yearly increase in student numbers reached a peak by 1933 with 184 enrolled students, a number which exceeded the capacity of the Physics department.[875] Trying to accommodate that many students made undertaking practical physics increasingly difficult with the available resources of space and staff. [876] An added complication to the departmental issue of limited laboratory space was that the final and honours student numbers had also increased, and by 1934 research laboratory space had reached its full capacity.[877] The department's

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[869] Philip G. Fothergill, *Historical Aspects of Organic Evolution* (London: Hollis and Carter, 1952).
[870] RBA, Annual Reports 1929-1932, *Eleventh Annual Report* (1931), p. 19.
[871] RBA, *Eleventh Annual Report*, p. 19.
[872] RBA, Annual Reports 1929-1932, Ninth Annual Report (1929), p. 15.
[873] RBA, *Eleventh Annual Report*, p. 19.
[874] RBA, Box no: 666, uncatalogued bundle 3 of 4, L. Wright, *The Department of Physics* University College of Swansea *1922-1945,* p. 6.
[875] RBA, Wright, p. 6.
[876] RBA, Annual Reports 1933-1935, *Fourteenth Annual Report* (1934), p. 58.
[877] RBA, Annual Reports 1933-1935, *Thirteenth Annual Report*, p. 53. *Fourteenth Annual Report*, p. 61.

solution was to appoint three part-time student demonstrators and a temporary assistant lecturer so that laboratory classes could be held every morning and every afternoon of the working week.[878]

The increase in students studying physics at Swansea went against the national trend, as according to the Department of Scientific and Industrial Research there was a scarcity of students applying for physics courses.[879] The reasons why physics remained popular at the University College of Swansea are difficult to pinpoint, however the appointment of Frank Llewellyn-Jones (1907-1997) as lecturer in 1932 enabled the department to offer teaching across the spectrum of physics.[880] An enthusiastic lecturer and researcher, Llewellyn-Jones' research in spectroscopy complimented the work of the department's head, Professor Evans, as well as teaching ionisation and the electrical breakdown of gasses.[881] Furthermore, as the science faculty had established a reputation as a metallurgical centre, it was appropriate for the Physics department to collaborate with the Metallurgy department to research the physical properties of alloys.[882]

The Development of Financial Student Support and the Question of Staff Salaries

The science faculty of Swansea University College was not alone in a significant increase in students at the beginning of the 1930s, it was a situation which was happening at universities nationally.[883] Berdahl's research into the development of British universities notes that the rate of enrolment increases from 1923 through to the academic session of 1928-29 was 3 per cent, and that this increased to 11 per cent from the academic session of 1929-30 to 1933-34. The increase according to Berdahl was due to the lack of job opportunities for school leavers, which was a consequence of a national economic depression and its accompanying high unemployment rate.[884] In Wales the unemployment rate went from 18 per cent in 1929 and increased to its highest

[878] RBA, *Fourteenth Annual Report*, p. 58.
[879] H. C. Harold Carpenter, *The Policies involved in the Organisation of Scientific Research by the State* (Cardiff: The University of Wales Press Board, 1931), p. 12.
[880] Obituary (1997, March), Professor Frank Llewellyn-Jones, *The Times*, p. 21
[881] Obituary, *The Times*, p. 21. Dykes, p. 126.
[882] Dykes, p. 126.
[883] Berdahl, p. 64.
[884] Berdahl, p. 64. For further reading on the financial policies in Britain during the 1930s and the social implications see; Roger Middleton, 'British Monetary and Fiscal Policy in the 1930s' *Oxford Review of Economic Policy*, vol. 26. 3 (2010), 414-441. Forrest Capie, *Depression and Protectionism: Britain between the Wars* (London: Routledge, 2003).

level in 1932 when the unemployment rate reached 38 per cent.[885] Heavy industries that were concentrated in South Wales such as the Tinplate and Steel industries were heavily affected by the depression and a lack of investment, with iron output falling by two-thirds from 926,500 tons to 279,800 tons between 1929 and 1931, and crude-steel production fell two-fifths from 2.3 million tons to 1.3 million tons.[886] Consequently the limited numbers of jobs available across Welsh industries was an encouragement for some young people to attend university. Furthermore, the creation and allocation of government grants were successful in encouraging and supporting young people who could not otherwise afford to study science at university.[887]

One of the first actions of the Department of Scientific and Industrial Research (DSIR) after its establishment was to create a system of maintenance allowances. From its establishment in 1916 to 1930 the department had allocated maintenance grants to 11,000 students to enable them to complete their scientific studies. There were concerns regarding the cost of this state support and whether such a large-scale expenditure should continue. A significant part of those concerns were questions on the type of scientific research that should be funded by the state.[888] While many of these discussions were specific to the allocation of research grants, the question of state maintenance grants for students was also part of the dialogue.[889] The research of Sabine Clarke puts into context the role of the DSIR in establishing a dialogue and identifying the appropriate terms which contributed to making state funding for scientific research more acceptable to its critics.[890]

Along with other universities the University of Wales was explicit in its recommendation that state funding should not only continue to support science students but that its expenditure should increase as, 'a very large expansion (of qualified scientists) will still have to take place if this country is to improve its position among the manufacturing nations of the world.'[891] However, concerns regarding the ability of students to pay their way while studying at university increased post 1929, and these

[885] Brinley Thomas, 'The Unemployment Cycle' in *The Welsh Economy Studies in Expansion* ed. by Brinley Thomas (Cardiff: University of Wales Press, 1962), p. 56.
[886] James Driscoll, 'Steel' in *The Welsh Economy Studies in Expansion* ed. by Brinley Thomas (Cardiff: University of Wales Press, 1962), p. 115.
[887] Carpenter, p. 12.
[888] Clarke, pp. 287-89.
[889] Clarke, pp. 293-94.
[890] Clarke, pp. 285-311.
[891] Carpenter, p. 14.

worries initiated a co-operative loan scheme for students in England and Wales.[892] At Swansea University College a Student Loan Fund was created in 1923 only a few years after the college was established.[893] The fund's creation originated from a donation of £78.19.0 from Dr F. W. Gilbertson who had been one of the major players in the campaign to establish a University College at Swansea. However, in 1931 two years after Gilbertson's death the Swansea College Fund was formally incorporated into three different student support organisations, the Co-Operative Loan Scheme, the National Union of Students and the Welsh Student Self-Help Council.[894] Eligibility for a Co-Operative loan was broad, however a student had to be a resident of Britain who had successfully completed a year of a degree course or were undertaking post-graduate research.[895]

An assessment of the applications of students studying science at Swansea University College who applied for the loan indicate that it was often the poverty of parents, caused by unemployment or a reduction of wages that initiated the loan application.[896] An example of a student who found herself in this situation was A. Phillips. After obtaining a degree in science Phillips wished to continue at the university to specialize in Physics, but her father had been unable to pay the fees. Mr Phillips was employed as a tinplate worker at the Mansel Tinplate works which like the rest of the industry had been affected by the adverse economic situation. Consequently, the industry retracted and drastically reduced the working hours and wages of employees. The university college authorities were aware that the institution had a high proportion of students who were capable of postgraduate study, but who were from working class families who had limited income.[897] To enable students to stay on at the institution after completing an Honours degree to undertake original research, the Senate adopted a recommendation to raise funds to establish a Postgraduate Scholarship Fund. The Senate made it clear that they did not wish to make a public appeal, instead a private appeal would be made to local industrial, business, and civic organizations and

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[892] RBA, reference no: UNI / SU / AS / 2 / 1 / 141, *Co-Operative Loan Scheme for Students.*
[893] RBA, UNI / SU / AS / 2 / 1 / 174, University College of Swansea session 1932-33.
[894] RBA, UNI / SU / AS / 2 / 1 / 174, University College of Swansea session 1932-33.
[895] RBA / UNI / SU / AS / 2 / 1 /141, *Co-operative Loan Scheme.* For further reading on student support in the 1930s see: Georgina Brewis, *A Social History of Student Volunteering: Britain and Beyond, 1880-1980* (Basingstoke: Palgrave Macmillan, 2014).
[896] RBA, reference no: UNI / SU / AS / 2 / 1 / 153, *Loan applications.*
[897] RBA, reference no: UNI / SU / AS / 2 / 1 / 117, Senate Committee, *Report concerning the question of the institution of a Postgraduate Scholarship Fund* (undated 1928-30?).

societies. In addition, the appeal was made internally to the Staff Club, as well as to the alumni of the university college.[898]

The hardship and unemployment during the 1930s in the South Wales region were not only a concern for the local authorities in Swansea, it also perturbed the Principal and his staff at Swansea University College.[899] Such consternations for the 'mental and moral' wellbeing of the local unemployed prompted the Principal to urge the Mayor of Swansea to initiate a conference of influential individuals to discuss these concerns. Principal Edwards believed that the educational and recreational needs of unemployed people should be addressed, and that this could be achieved by establishing practical educational courses and daily classes in various centres throughout Swansea. A promise of help in organising the scheme and in delivering the classes was given by Edwards and the staff at the university college. The university's involvement was a clear illustration of how the institution recognised its role to serve the educational needs of the local community and industry.[900] Yet, it was also an example of the many types of schemes offering support for the unemployed which were established nationally at educational communities, centres and clubs.[901]

Research into the agenda, support, and the success of such schemes by Andrzej Olechnowicz reveal that the reality of who 'the unemployed' were and what support they required was often generalised. This is evident from the experience of an unemployed man in South Wales, who stated:

> You see, I've the qualifications for a teacher or a warden, though I didn't manage to get a chance to study for my examinations […]. I wrote saying I was qualified to look after men, I knew them all and their problems. But they didn't give me any job. Some young chap from Cambridge came down, got a nice salaried post.[902]

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[898] RBA / UNI / SU / AS / 2 / 1 / 117.

[899] RBA, UNI / SU / AS / 2 / 1 / 151, Principal Edwards, *Letter to the Mayor of Swansea.* For further reading on the inter-war period of depression see: John Stevenson and Chris Cook, *Britain in the Depression: Society and Politics, 1929-1939*, 2nd edn (London: Longman Ltd., 1994). Colin A. Linsley and Christine L. Linsley, 'Booth, Rowntree, and Llewellyn Smith: A Reassessment of Interwar Poverty', *Economic History Review,* 46. 1 (1993), 88-104. Keith Laybourn, *Britain on the Breadline: A Social and Political History of Britain between the Wars* (Gloucester: Alan Sutton 1990).

[900] RBA / UNI / SU / AS / 2 / 1 / 151 / 154.

[901] Andrzej Olechnowicz, 'Unemployed Workers, 'Enforced Leisure' and Education for 'The Right Use of Leisure' in Britain in the 1930' in *Labour History Review* vol 70 (April 2005), 27-52 (p. 37). For further reading on unemployment during this period see: N. F. R Crafts, 'Long-term Unemployment in Britain in the 1930s', *Economic History Review,* 40. 3 (1987), 418-32.

[902] Olechnowicz, p. 41.

While there were issues regarding the remit of many of the voluntary schemes to support the unemployed, the scheme initiated by the University College of Swansea was mainly concerned with educational opportunities for unemployed workers.[903] Regular classes were held by a senior member of the Metallurgy department, Assistant Professor Taverner and other members of the university staff at the Old Hafod School in Swansea.[904]

Unemployment rates amongst graduates also rose during the 1930s, both nationally and internationally.[905] This was a matter of serious concern for universities and colleges, yet as the management of universities became increasingly complex the management and supervision of students became standard. This enabled universities to monitor and support its vulnerable students, as well as offering opportunities through foreign exchanges.[906]A small university college such as the Swansea institution was able to assess the scale of its unemployed graduates, as well as monitor its employed graduates progress in the job market. The 1934-1935 report of the Swansea University College's committee concerning student employment recorded that of the 138 students who left the institution that year, 46 were unemployed.[907] Of the remaining students 81 returned to the college to engage in further studies.[908]

To address the issue of unemployed graduates the university put in place a system of support for students, which was an early example of careers advice. During the 1935-1936 session Principal Edwards in his role as chairman of the Appointments Committee interviewed all students who were to graduate that session, and those individuals who were unsure about their career direction were identified.[909] By having regular informal meetings with these students the Advisory Committee hoped to give them the encouragement and direction to decide on a career choice. Additional practical support was also given in the form of basic training on how to write a successful job application.[910] This initiative was developed with the appointment of the college's extra-mural studies lecturer, P. S. Thomas as a careers advisor, who compiled and circulated a selection of literature from the Civil Service and other organisations on

[903] Olechnowicz, pp. 33-44, RBA, *12th Annual Report*, p. 49.
[904] RBA, *12th Annual Report*, p. 49.
[905] Gerbod, pp. 116-117.
[906] Gerbod, p. 117.
[907] RBA, reference no: UNI / SU / AS / 2 / 1 / 210, College Committee, *Report of the College Committee concerning appointments for Students* (1934-1935).
[908] RBA / UNI / SU / AS / 2 / 1 / 210, *Appointments for Students*.
[909] RBA, UNI / SU / AS / 2 / 1 / 210, *Appointments for Students.*
[910] RBA / UNI / SU / AS / 2 / 1 / 210, *Advisory Committee Report*.

career opportunities.[911] Thomas also organised talks for first and second year students on the different opportunities open to university graduates other than the teaching profession.[912]

Encouraging science and arts graduates away from selecting a career away from the over-subscribed teaching profession was a challenge for the University of Wales. Graduates from universities in England, Scotland and Ireland were more likely to choose careers in different walks of life, and traditionally selected careers in the various departments of the Foreign Office.[913] Careers that were available for science students in the Foreign Office were often in Agriculture. Yet there was no such tradition with the constituent colleges of the University of Wales, apart from a minor connection between Aberystwyth University College and the Egyptian Services.[914] This anomaly in Welsh graduates' career choices was discussed by E. H. Jones, the University of Wales representative on the Preliminary Interviewing Committee at the India Office in a letter to the Bishop of Monmouth, the Pro-Chancellor of Wales. Jones was critical of the standard of the very few applicants that apply for overseas service from the Welsh colleges, in comparison to the qualities of candidates from universities from other regions of Britain. Jones suggested that there were cultural reasons why Welsh students did not apply in larger numbers for posts overseas, writing that the working-class background of many Welsh students did not encourage overseas travel. Jones continued with his generalizations of Welsh students by suggesting that Welsh students' families had no traditional links with the imperial services and were unaware of the opportunities the services offered.[915]

Offering opportunities for science students to plan a career in industry rather than a career in teaching or academia was necessary, as the element of 'intellectual snobbery' regarding the research of applied science within the sphere of industry was still evident.[916] Due to the central place of research in potential careers for science graduates, the science faculty at the Swansea University College offered guidance and

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[911] RBA, UNI / SU / AS / 2 / 1 / 234, *Report of Advisory Committee on appointments for Students* (session 1936-1937).

[912] RBA / UNI / SU / AS / 2 / 1 / 234.

[913] RBA, UNI / SU / AS / 2 / 1 / 254, E. H. Jones, *Letter to the Bishop of Monmouth Pro-Chancellor of the University of Wales* (18 July 1938).

[914] The unpublished thesis *In Egyptian Service: The Role of British Officials in Egypt, 1911-1936* (St. Antony's College, Oxford University,1986) by Mary Innes gives a comprehensive account of the opportunities which were open to British graduates in Egypt.

[915] RBA, UNI / SU / AS / 2 / 1 / 254.

[916] Beveridge, pp. 127-129.

practical opportunities for research students through the actions of Applied Science Advisory committees.[917] Separate committees dealt with the different sections of metallurgy and engineering, and with each committee including representatives from appropriate industrial corporations and firms. The main aim of the committees was to encourage research which would improve industrial processes, and this was partly achieved by offering student and graduate placements in positions offering opportunities to their development.[918] This practical support enabled students and graduates to have the experience of undertaking directed research under large-scale industrial conditions.[919] It also encouraged closer connections between academia and industry, relationships which were considered important by individuals like Professor H.C. Harold Carpenter. Carpenter believed that to educate generations of highly trained industrial scientists a bridge had to be built between the 'new science of discovery' and the processes where it is to be developed and worked.[920]

Unemployment was the visible sign of an economic decline, but many who were in employment had their salaries decreased or left stagnant. University staff had suffered from a stagnation in their salaries, which was mostly due to the limited size of Government grants which were awarded to universities and colleges. Concerns regarding the status and salaries of university staff came to a head in 1920 and led the Association of University Teachers (AUT) to undertake a national survey, and its result revealed that the salaries of a significant number of teaching staff were well below the minimum amount set by the AUT scale.[921] The University of Wales responded to the survey and sent official data on the constituent Colleges of Aberystwyth, Bangor and Cardiff. As the University College of Swansea had just been established that year there were no official data on its staff. The AUT considered the findings of the report to be serious, and if not addressed could be an impediment to the successful progression and delivery of university education. The report was considered evidence of the urgent need for change, therefore copies of the report were sent to the Government and the various government departments connected to university education.[922] The following year in

[917] RBA, UNI / SU / AS / 2 / 1 / 238, *Report of Educational Works, Faculties and Subjects* (session 1937-1938).
[918] RBA / UNI / SU / AS / 2 / 1 / 238, *Report of Educational Works*.
[919] Swansea Museum Library, Box no: 88 reference no 79/23, H.C. Harold Carpenter, *The Policies involved in the Organisation of Scientific Research by the State* (Cardiff: University of Wales Press Board, 1931), pp. 12, 36.
[920] Carpenter, p. 12.
[921] RBA, UNI / SU / AS / 2 / 1 / 33, Association of University Teachers, *Report on Salaries* (1920).
[922] RBA / UNI / SU / AS / 2 / 1 / 33, *Report on Salaries.*

1921 a Conference of University Governors and Teachers proposed and accepted a scale of minimum salaries for university teachers.[923]

By the end of the decade the situation regarding university staff salaries had improved for junior staff, but the university Governing Bodies had been unable to increase the other grade of lecturers especially grades I and II.[924] The academic career ladder was generally divided into three grades of status and salary, the post of Professor being grade I, grade II consisted of Assistant Professors, Readers, Lecturers, and grade III were the Assistant Lecturers or the Junior Lecturer.[925] It was accepted that grade III posts were mostly probationary especially in the first year of employment, however, the nomenclature and system of grading for academic staff varied from university to university.[926] The salaries of lecturers on grades I and II compared very unfavourable with secondary school teachers and scientists engaged in Government and Industrial Research Departments. The AUT believed that these financial disadvantages dissuaded individuals from choosing a career in academia or continuing a career path in the university sphere, thereby losing potentially excellent teaching staff. The salary grading scheme incorporating three levels remained unchanged until 1947 when the salary grade of the post of Senior Lecturer was recognised. The promotion to the salaried post of Senior Lecturer was awarded on the merits of proven departmental responsibility, teaching capabilities and quality of published research or comparable work.[927] The post of Senior Lecturer was established at the University of Wales on the 1 October 1947.[928]

Universities authorities were partly responsible for the reluctance of the Treasury to increase university government grants, as instead of using the grants to increase salaries and improve libraries the universities used the funds for curriculum expansion.[929] In its report of 1930 the University Grants Committee (UGC) sternly suggested to the universities that they should not venture into expanding their curriculum, until they had made progress on staff salaries and improving libraries. The UGC concluded with a warning:

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923 RBA, reference no: UNI / SU / AS / 2 / 1 / 133, Association of University Teachers, *Letter to the Governing Bodies of the Universities and University Colleges of England and Wales.*
924 RBA / UNI / SU / AS / 2 / 1 / 133, *Letter to the Governing Body.*
925 Bruce Truscot, *Red Brick University* (Harmondsworth: Penguin Books, 1951), pp. 108-111.
926 Truscot, p. 109.
927 RBA, reference no: UNI / SU / AS / 2 / 1 / 375, University of Wales, *Report of a Meeting of the Standing Committee of Principals held at Beaumaris* (2 March 1947), p. 2.
928 RBA / UNI / AS / 2 / 1 / 375, *Standing Committee of Principals*, p. 2.
929 Berdahl, p. 65.

> We shall be profoundly disappointed if, at the end of another quinquennium, we have once more to inform [the Treasury] that it is for expenditure upon these two items that additional income is in general most urgently required.[930]

In 1930 to aid the university authorities to deal with the serious question of limited university staff salaries, the government increased the amount of state aid awarded in the form of Government Grants.[931] Consequently, the University of Wales received its increased Government Grant for its four constituent colleges with an added amount of £3, 029 for the Swansea University College.[932] The additional finance given to Swansea was to address the specific issues raised by the AUT: increasing the salaries of non-professional staff, the salaries of independent lecturers, and the salaries of librarians. The Finance Committee were unanimous in the decision to appropriate the extra money the institution received from the government grant to bringing staff salaries into line with the other constituent colleges.[933]

Swansea University College's assessment and upgrade of its staff salaries were driven by the influences of two parallel communities, the national university community, and the federal system of the University of Wales. In 1930 there was a reappraisal of salaries by the Swansea University's Finance and General Purposes Committee of various grades of the teaching staff.[934] The appraisal was a step towards implementing a compulsory adoption of a uniform scheme of salaries across the four constitute colleges of the University of Wales. An example of salary discrepancies within the federal system was the lower rate paid to the junior lecturers at Swansea compared to the salary rate paid to junior staff in similar positions at Cardiff University College. To close the gap on this discrepancy by increasing the independent lecturer's salaries from £550 to £650 per annum would cost Swansea University College £4,300. The University of Wales was also aware that the average salary of £800 that its constituent colleges paid its professional staff was not high enough to attract or prevent Professors from taking positions elsewhere.[935] The inconsistency in salaries was across

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930 Cited in Berdahl, p. 65.
931 RBA / UNI / SU / AS / 2 / 1 / 133, *Letter to the Governing Body*.
932 RBA, UNI / SU / AS / 2 / 1 / 134, *Council of the University of Wales.*
933 RBA, UNI / SU / AS / 2 / 1 / 134, *Council of the University of Wales.*
934 RBA, UNI / SU / AS / 2 / 1 / 134, *Report to the Secretary of the Council of the University of Wales* (17 September 1930).
935 RBA / UNI / SU / AS / 2 / 1 / 134, *Report to the Council.*

the range of professional staff and was prevalent amongst universities in Britain, with salaries ranging from £300 to £2,000.[936]

As with the stagnant situation with junior salaries, there had been limited progress in increasing professional salaries during the previous decade. In fact, the average professional salary of £800 in 1930 was considered by the AUT to be the national medium salary for Professors in 1920.[937] Salary increases due to the growth in state grants was slow to reach junior and support staff, and this static progress of salaries caused consternation throughout the 1930s. At the science faculty at the University College of Swansea, the heads of the different departments became actively involved in the conversations of staff wages and conditions.[938] Professors Mockeridge, George and Coates wrote to the Registrar Mr. Drew and requested him to ask the Financial and General Purposes Committee for the necessary increase in the wages of their departmental laboratory staff. All three letters revealed a level of frustration from the authors with the university authorities. Both Mockeridge and Coates felt the need to remind the university of the increasing workload of their respective laboratory staff Mr. Thomas and Mr Naylor, by giving an extremely detailed description of the skilled and semi-skilled duties and responsibilities of both men.[939] Furthermore, Professor Coates reminded the university authorities that he had to repeat his request for an increase in Naylor's wages, due to their lack of response.[940] A similar response was experienced by George with his request for an increase in the wage of the Geology laboratory assistant Mr. T. C. Marchand, however this second request had been written by the former Head of Department, Professor Trueman.[941] None of these requests were acted on by the authorities of the university college, and by 1940 Mockeridge was yet again writing to the Registrar on behalf of Mr. Taylor, who at this point had been working in the Biology Department for 18 years.[942]

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[936] RBA / UNI / SU / AS / 2 / 1 / 33, *Association of University Teachers* (1920).
[937] RBA / UNI / SU / AS / 2 / 1 / 33, *Association of University Teachers.*
[938] RBA, UNI / SU / AS / 2 / 1 / 195, Neville George, *Letter to Mr. Drew Registrar* (8 October 1934, UNI / SU / AS / 2 / 1 / 198, Florence Mockeridge, *Letter to Mr Drew Registrar* (20 February 1935, UNI / SU / AS / 2 / 1 / 201, J. E. Coates, *Letter to Mr Drew Registrar* (29 March 1936).
[939] RBA / UNI / SU / AS / 2 / 1 / 198, Professor Mockeridge, *Letter to Registrar Mr. Drew* (20 February 1935). UNI / SU / AS / 2 / 1 / 201, Professor J. E. Coates, *Letter to Registrar Mr. Drew* (6 February 1936).
[940] RBA / UNI / SU / AS / 2 / 1 / 201, *Letter to Registrar.*
[941] RBA / UNI / SU / AS / 2 / 1 / 198, *Letter to Registrar.*
[942] RBA, UNI / SU / AS / 2 / 1 / 288, Professor Mockeridge, Letter to Mr. Drew, Registrar (5 March 1940).

The Disruption of War

A year earlier the outbreak of World War II gave Coates the opportunity to try another tactic in his efforts to raise the wages of his laboratory staff, Mr. Jepson and Mr. Naylor, bypassing the university authorities and appealing instead to Sir Robert Robertson (1869-1949) who was Director of the Directorate of Explosives Research (later known as the Armaments Research Department, ARD).[943] With the outbreak of World War II Robertson came out of retirement to head a major branch of the Woolwich Arsenal, the ARD, which had been deployed to the University College of Swansea.[944] Robertson's previous long distinguished career as a chemist and explosives expert had earned him the appointment as the government chemist of a research department at the Woolwich Arsenal.[945] Coates used the fact that the extra work pressures initiated by the occupation of the ARD on the staff of the department was a qualified reason to raise the laboratory staff's wages.[946] While acknowledging that there was extra funding for staff under 'services' in estimated expenditure, Robertson made it clear that he did not wish to discuss staff wages. He stated that in future correspondence 'no special mention should be made of individual's wages.' Robertson's response could be interpreted as not wishing to be involved in an internal university policy, but the tone of the letter suggests an assertion of his seniority as a representative from the military over Coates' departmental authority as a department head at the science faculty.[947]

The afore mentioned spat between Robertson and Coates in 1939 was an insignificant event in the relationship between the ARD and the University College of Swansea. However, it was an indication of the shift of authority within the institution from academic to state in the context of the disruption to the science faculty.[948] While authority within the university system is an essential feature, it was also according to Ashby and Anderson a responsibility which was shared amongst its academic staff.[949] The arrival of the ARD with 90 research staff (which rose to over 150 according to

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[943] Grace's Guide British Industrial History, *Robert Robertson 1869-1949* (2016), https://www.gracesguide.co.uk/index.php?title=Robert_Robertson_(1869-1949)&oldid=858416 [accessed 10 August 2018]. RBA, UNI / SU / AS / 2 / 1 / 256, Professor Coates, *Letter to Sir Robert Robertson, Director of Directorate of Explosives Research* (10 October 1939).
[944] Grace's Guide (2016).
[945] Grace's Guide (2016).
[946] RBA / UNI / AS / 2 / 1 / 256, Coates letter to Robertson.
[947] RBA / UNI / AS / 2 / 1 / 256, Sir Robert Robertson, *Letter to Professor Coates* (22 November 1939).
[948] RBA / UNI / SU / AS / 2 / 1 / 275, Directorate of Explosives Research, *Letter to the Registrar, E. Drew* (10 October 1930).
[949] Eric Ashby and Mary Anderson, *The Rise of the Student Estate in Britain* (London and Basingstoke: Macmillan and Co., Ltd., 1970), pp. 149-50.

Dykes) changed the dynamics and authority of the science faculty as the Chemistry department, and sections of the Physics and Metallurgy departments became occupied by government scientists.[950] This area of development was not unique to the Swansea institution, as the demand for research that supported the war effort prioritized academic research space for government projects. Other government research 'occupations' included the ARD's use of the Engineering department at Nottingham University and the deployment of the RAE (Royal Aircraft Establishment), Farnborough to the Singer Laboratories at Exeter University.[951]

Yet, the Swansea institution was alone amongst the University of Wales constituent colleges of having a government research department occupying its campus.[952] While Swansea's sister college at Aberystwyth was not involved in any government research project, it was involved in education that pertained to the war effort. In 1941 two new areas of training were established at the institution, a 'department of radio' was set up to train Ministry of Labour personnel in communications, with map-reading and elementary astro-navigation courses arranged for Royal Air Force (RAF) personnel.[953] Such major changes were expected during war-time as the constitutional relationship between the government, its people and its institutions are radically changed.[954] No more is this evident than in the implementation of the Emergency Powers Acts of 1939, the scope of which was extensive and complicated. The legislation of the Acts empowered the central government to control every aspect of society including the regulation and control of local government and universities.[955]

The implementation of rationing under the emergency powers had a direct influence on many aspects of civilian life and that included the running of university institutions. There is evidence that the university college contested certain aspects of the rationing imposed on the institution. Using its obligation as host to the ARD in providing

[950] Dykes, p. 143.
[951] Sanderson, *The Universities and British Industry*. pp. 340-41.
[952] Morgan, pp. 21-3.
[953] Morgan, p. 23.
[954] Jennings, p. 1.
[955] Jennings, pp.1- 5. The conspectus of Jennings reveals how extensive this legislation affected local authorities. For further reading on the mobilisation for the Second World War in Britain see: James Greenhalgh, 'The Threshold of the State: Civil Defence, the Blackout and the Home in Second World War Britain', *20th Century British History* 28. 2 (2017), 186-208. For reading on specific negative aspects of mobilisation see: Gary Willis, 'An Arena of Glorious Work': The Protection of the Rural Landscape against the Demands of Britain's Second World War Effort', *Rural History* 29. 2 (2018), 259-280. Mark James Crowley, 'Produce More Coal'='Produce More Silicosis? Re-training, Re-employment, and Respiratory Illnesses in the South Wales Coalfield, 1938-1945', *Labour History Review*, 82. 3 (2017), 215-250.

facilities for its essential research, the institution's authorities petitioned the local Fuel Overseer against the rationing of its gas, electric and fuel.[956] There is no surviving primary source evidence that reveals whether this request was granted or not, but what is apparent from the primary sources is the extent of the ARD's physical presence on the Swansea campus. Arranging the accommodation at the university college for the ARD was the role of the Ministry of Supply Research Department, who rented a total of 12,278 sq. ft. of the college buildings for £879 per annum.[957] The rented accommodation initially included space in the Chemistry, Physics, Engineering departments as well as the library. However, as the project progressed further space was required, and the science faculty was deprived of an additional 552 ft of departmental space.[958]

The reorganisation put immense pressure on departmental heads who had to rearrange their departments teaching and research schedules to fit in with the requirements of the government department.[959] In particular, the planning skills of Coates were acknowledged in ensuring that the Chemistry department was adaptable to the changes during this difficult period.[960] Unfortunately, not all departmental planning ran so smoothly as illustrated by the debacle over the timetable for chemistry lectures during the 1941-42 session.[961] After the rearrangement of the timetable the chemistry teaching staff were informed of the changes, but Coates was not. Consequently, Coates failed to attend one of his lectures and his displeasure and frustration are obvious in his letter to Drew, the registrar.[962] While it was to be expected that during this pressing period mishaps would occur the situation was not helped by the limited numbers of administrative staff. The war further affected the work of the registry, as one of the few clerks, Albert Devonald volunteered for active service in 1939.[963] This put a further workload on Drew whose own duties as the senior administrator officer and secretary to the governing bodies of the institution were many.[964]

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[956] RBA, UNI / SU / AS / 2 / 1 / 274, Drew, College Registrar, *Letter to J.R. Heath, Local Fuel Overseer* (12 October 1939).
[957] RBA, UNI / SU / AS / 2 / 1 / 328, Ministry of Works, *Letter to the Registrar* (30 March 1943).
[958] RBA, UNI / SU / AS / 2 / 1 / 328, Ministry of Works.
[959] RBA, Swansea University Archive Collection, Box no: 664, *Tribute to Emeritus Professor J. E. Coates, O.B.E., D.Sc., F.R.I.C.*
[960] RBA, Box no: 664, *Tribute to Coates.*
[961] RBA, UNI / SU / AS / 2 / 1 / 296, Professor Coates, *Letter to the Registrar*, E. Drew (2 October 1941).
[962] RBA, UNI / SU / AS / 2 / 1 / 296, *Letter to the Registrar.*
[963] Dykes, p. 143, Devonald ended the war as a captain in the Ghurka Regiment and mentioned in dispatches.
[964] Dykes, p. 84.

As government research departments moved into academia there was a flow of university science staff being re-deployed into government and industry.[965] Swansea University College was no exception with scientists such as Norman Hartshorne from the Chemistry Department being drafted in 1940 to the army chemical warfare section as a staff captain.[966] The mobilisation for war affected a substantial percentage of the British workforce as illustrated in the comparative diagram below.

Figure 7: Mobilization of the Workforce for War: U.S.A., U.K., U.S.S.R., and Germany, 1939/40 and 1943.

		Group I Industry	Armed Forces	Total War-related
	1940	8.4	1.0	9.4
U.S.A.	1943	19.0	16.4	35.4
	1939	15.8	2.8	18.6
U.K.	1943	23.0	22.3	45.3
	1940	8.0	5.9	14.0
U.S.S.R.	1943	31.0	23.0	54.0
	1939	14.1	4.2	18.3
Germany	1943	14.2	23.4	37.6

Reference: Mark Harrison, 'Resource Mobilization for WWII.'[967]

As the war progressed the deployment of increasing numbers of staff from across both the arts and science faculties created staffing difficulties for the institution.[968] Consequently, the response from senior staff was not always what was expected. As illustrated by the Geology department's head, Professor George's reaction to the request by the Ministry of Labour and National Service (MLNS) to release David Trevor Williams for war work.[969] George was not willing to agree to the request as Williams' research and teaching commitments in the department were considerable. It was also pointed out to the MLNS that Williams had already given service to the war effort by

[965] Morgan, p. 341.
[966] Dykes, p. 143.
[967] Mark Harrison, 'Resource Mobilization for World War II: the U.S.A., U.K., U.S.S.R., and Germany, 1938-1945' *University of Warwick* (1988), 1-26, https://warwick.ac.uk>fac>soc>economics>staff>mharrison>public/ehr88postprint-pdf , p. 18.
[968] Dykes, p. 143.
[969] RBA, UNI / SU / AS / 2 / 1 / 296, Professor George, *Letter to the Registrar, E. Drew* (8 December 1941). Ministry of Labour and National Services, *Letter to the Registrar, E. Drew* (4 December 1941).

working with various government departments, including Lord Reith's Committee on Construction and the Admiralty.[970]

It is apparent that the university scientist became an increasingly vital player in all areas of scientific research conducted for the war effort, as well as being involved in government scientific decision-making.[971] Sanderson cites the example of Lord Cherwell of the Clarendon Laboratory and acting advisor to Churchill as well as Professors Bernal and Zuckerman who advised Lord Mountbatten.[972] Yet, many of the scientists employed on wartime research projects were young graduates, as evident by the hundreds of scientists who worked at the Telecommunications Research Establishment (TRE) and the Radiation Laboratory located at the Massachusetts Institute of Technology, USA.[973] The scientists were enlisted from across many disciplines, especially physics, and were organised into a highly structured and target-orientated working environment. These working practices would define the experience of post-war 'big science' projects, and as Jon Agar asserts 'academic scientists were learning what industrial and military science was like'.[974]

Yet, the government research departments that entered the academic environment to undertake war work operated within their own working guidelines. This was clearly the practice of the ARD throughout their seven years at the University College of Swansea (1939-1946).[975] Due to the secrecy of their research the ARD effectively established themselves as a research community operating within an established academic community. From the beginning of their establishment at the university college the ARD made it apparent to the registrar that the rooms they occupied were to be off limits, locked and could only be opened with a specific master key.[976] Furthermore, the security of the college which was undertaken by the institution's groundsman was not considered appropriate by the ARD. The registrar was informed that the security of the

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970 RBA, UNI / SU / AS / 2 / 1 / 296, Professor George, *Letter to the Registrar, E. Drew* (8 December 1941). For further reading on attitudes and people's experience of the war see: Angus Calder, *The People's War: Britain 1939-1945* (London: Jonathan Cape Ltd., 1969).
971 Sanderson, *The Universities and British Industry*, pp. 340-41.
972 Sanderson, *The Universities and British Industry*, p. 341.
973 Agar, pp. 272-73.
974 Agar, pp. 272-73. For further reading on the changing boundaries within scientific research or 'hybrid institutions' see: Audra J. Wolfe, *Competing with the Soviets: Science, Technology, and the State in Cold War America* (Baltimore: The Johns Hopkins University Press, 2013).
975 Morgan, p. 21.
976 RBA, UNI / AS / SU / 2 / 1 / 275, Directorate of Explosives Research, *Letter to the Registrar, E. Drew* (10 October 1939). RBA, UNI / AS / SU / 2 / 1 / 275, Directorate of Explosives Research, *Letter to the Registrar, E. Drew* (24 November 1939).

ARD research area would be undertaken by their own staff who would provide a continuous patrol.[977] An example of the separation of the ARD from the rest of the science faculty was illustrated by the contentious issue of an outdoor storage facility. The urgent need for an outdoor building to store inflammable material had been a topic of discussion for the Chemistry department, and the problem was considered solved with the arrival of the ARD who proceeded to erect isolated brick buildings for storage.[978] The storage facility was meant to serve both the needs of the Chemistry department and the ARD, but the latter monopolised the space. This led a frustrated Coates to declare to the registrar that 'the department contains so much inflammable liquid of various kinds that in case of bombing it would be impossible to save the building'.[979]

Departmental space in the science faculty was at a premium during the war years as the institution hosted 110 students and staff from the Engineering department of the University College of London who were evacuated to Swansea.[980] This was not the only department from the UCL that were evacuated, as other departments were moved to the institutions of Aberystwyth, Bangor, Cardiff, Sheffield, Oxford and Cambridge.[981] This proved to be a fortuitous move as the following year the UCL was badly bombed.[982] In addition to the UCL evacuees, 30 staff and students were transferred from the Metallurgical department of the Imperial College London.[983] Verified evidence of why the Swansea institution was chosen to host the ARD and the UCL's Engineering department has not emerged to-date, but what is clear is that the metallurgy departments of the Imperial College and the University College of Swansea had a connection through their heads of department, Sir Harold Carpenter and C. A. Edwards. Both scientists had worked at Victoria College, Manchester, where Carpenter had been Edwards' senior.[984] This professional connection might be one of the reasons why Carpenter opted to move his students to the University College of Swansea during

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[977] RBA, UNI / AS / SU / 2 / 1 / 275, Directorate of Explosives Research, *Letter to the Registrar, E. Drew* (24 November 1939).
[978] RBA, UNI / AS / SU / 2 / 1 / 296, Professor Coates, *Letter to the Registrar, E. Drew* (2 October 1941).
[979] RBA, UNI / AS / SU / 2 / 1 / 296, *Letter to the Registrar.*
[980] Drew, p. 143.
[981] Sanderson, *The Universities and British Industry*, p. 340.
[982] Sanderson, *The Universities and British Industry*, p. 340.
[983] RBA / UNI / AS / SU / 2 / 1 / 274, UCS Registrar, Drew, Letter to J. R. Heath, Local Fuel Overseer (12 October 1939).
[984] C. A. Edwards, 'Henry Cort Harold Carpenter. 1875-1940' *Obituary Notices of Fellows of the Royal Society*, vol. 3. 10 (December 1941), 610-625, https://www.jstor.org/stable/769170 .

the war years. Furthermore, unlike the ARD, the staff and students from the London institutions integrated fully into the life of the university college, both academically and socially.[985]

The metallurgy department's integration with its host had long term consequences for research at the London College. The research of Hannah Gay asserts that the new ideas were brought back to the college department, and consequently concentrated redirected its assaying research to extraction metallurgy rather than assaying after the war.[986] The influx of evacuated science students ensured that there was a return to the early predominance of full-time science students over arts students throughout the war years.[987] This is revealed in a comparative breakdown of faculty student numbers for the academic sessions of 1939-1940 and 1945 to 1946 which are shown in the tables below.[988]

Figure 8: Breakdown of Student Numbers for the Academic Year 1939-1940

	Arts		**Pure Science**		**Applied Science**		**Medicine**		
	Men	Women	Men	Women	Men	Women	Men	Women	Total
Post graduate Students									
Full Time	6	3	14	0	1	0	0	0	24
Part Time	0	0	0	0	0	0	0	0	0
Degree Students									
Full Time	152	45	74	13	91	0	5	6	386
Part Time	3	0	0	0	1	0	0	0	4
Diploma Students									
Full Time	37	17	0	0	3	0	0	0	57
Part Time	10	2	0	0	0	0	0	0	12
Other Students									
Full Time	0	0	0	0	0	0	0	0	0
Part Time	1	1	1	0	15	0	0	0	18
Total	209	68	89	13	111	0	5	6	501

Reference: University College of Swansea, Twentieth Report of the Council (1939-1940)

[985] Hannah Gay, *The History of Imperial College London, 1907-2007: Higher Education and Research in Science, Technology and Medicine* (London: Imperial College Press, 2007), pp. 167 -168.
[986] Gay, pp. 168, 170.
[987] Morgan, 1997.
[988] University Council of Swansea, *Twentieth Report of the Council* (1939-1940), *Twenty-sixth Report of the Council* (1945-1946).

Figure 9: Breakdown of Student Numbers for the Academic Year 1945-1946

	Arts		Pure Science		Applied Science		Medicine		
	Men	Women	Men	Women	Men	Women	Men	Women	Total
Post graduate Students									
Full Time	6	1	6	0	1	0	0	0	14
Part Time	1	0	0	0	0	0	0	0	1
Degree Students									
Full Time	76	76	72	39	108	1	7	4	383
Part Time	0	0	0	0	0	0	0	1	1
Diploma Students									
Full Time	49	27	0	0	2	0	0	0	78
Part Time	9	8	0	0	0	0	0	0	17
Other Students									
Full Time	0	0	0	0	0	0	0	0	0
Part Time	37	6	13	1	5	0	0	0	62
Total	178	118	91	40	116	1	7	5	556

Reference: University College of Swansea, Twenty-sixth Report of the Council (1945-1946)

In a 1945 report on the staffing needs for Mathematics, Physics and Chemistry it states that the large increase in student numbers during the war stretched departmental staff to the limit.[989] This was just one of the immediate post-war departmental communications that stressed the urgency for increased staffing levels, as well as improved teaching and research facilities.[990]

Conclusion

To conclude, the University College of Swansea managed to survive the serious challenges that its second decade brought, yet at a cost to departmental developments at the science faculty. The close-knit science community which had evolved through the trials and tribulations of establishing and developing the different science departments were disrupted by staff resignations and departmental stagnation. While transient work patterns were an accepted part of an early academic career, the turnover of key members of staff at this early stage in the development of the science faculty created unease

[989] RBA, reference no; UNI / SU / AS / 2 / 1 / 356, *Report on the immediate staffing needs of the Departments of Mathematics, Physics and Chemistry* (1945).

[990] RBA, reference no: UNI / SU / AS / 2 / 1 / 360, J. E. Coates, *Letter to Principal Edwards* (17 September 1946). UNI / SU / AS / 2 / 1 / 358, Professor Llewellyn-Jones, *Report on the Immediate and Post-War needs of the Dept of Physics* (1946).

amongst the remaining staff. However, the cohesive nature of the individual departmental communities ensured that new staff members were successfully integrated which encouraged continuity with departmental curricula and research projects. This was especially apparent in the Metallurgy department when successive senior staff successfully administered the department when Professor Edwards followed Sibly as Principal. However, by giving Edwards dual roles, the college authorities seriously underestimated the working demands of an academic scientific department. This was not the only miscalculation made by the college authorities during the 1930s, as the attempts to deal with the historical inadequate teaching and laboratory space affecting the Biology and Geology departments failed in the light of departmental growth and success. These situations implied a lack of a long-term strategy by the college's authorities, with the implementation of short-term staffing and teaching accommodation measures was not enough to halt increasing concerns of maintaining teaching standards.

Indeed, limited space and inadequate staff numbers did have a bearing on the institution's scientific academic reputation, as such problems had a direct negative influence on the expansion of scientific postgraduate studies and research projects. However, the ingenuity of senior staff in utilising limited resources to accommodate important resources such as departmental museums and negotiating external research facilities halted any major decline. Unfortunately, the implementation of expansion plans, most notably a building to accommodate the increasing numbers of natural sciences students and expand faculty facilities were blocked by the fall-out of the global depression of the 1930s. The economic depression created industrial recession, and high unemployment encouraged a rise in students at a time when government spending on universities was curbed. Yet, a continuing national demand for science graduates encouraged the government Department of Scientific and Industrial Research to initiate the payment of maintenance grants to support science students through a time of social hardship.

Financial support for students was historic at the University College of Swansea as it had an established student loan fund since 1923, however, the creation of a private postgraduate scholarship fund addressed the increasing poverty of its research students. Additionally, the rise in local unemployment prompted the university college to recognise its community obligations, as well as making provisions to address and curb the rise in unemployment amongst its graduates. Furthermore, the national recession and high unemployment affected job opportunities within universities, as teaching and academic posts were oversubscribed and salaries within academia had stagnated. The consequence of academic salary stagnation meant wages compared unfavourable with school or industrial posts and dissuaded potentially excellent teaching staff from applying for academic positions. The institution's successful application for government aid enabled the subsequent upgrading of its independent lecturers' salaries to fall in line with the other constituent colleges of the University of Wales. However, despite the involvement and persistent determination of departmental heads the university college authorities failed to increase the wages of departmental laboratory staff.

Finally, any plans to expand the facilities of the science faculty at the end of the institution's second decade were halted by World War II and its consequences affected the institution on a personal basis. Moreover, increasing collaborations between the military, industry and academia ensured that science departments and science staff played vital roles in the mobilization of science for wartime needs. In addition, university staff were re-deployed to undertake essential war-work at other research institutions, and this created further teaching and administrative staff shortages. Yet, it was the occupation of the Armaments Research Department of the Woolwich Arsenal that disrupted the familiar business of the science faculty as the secrecy of its research generated a sense of isolation and 'otherness' from the rest of the scientific community. In addition, academic authority for the teaching and research areas that were allocated to the ARD was diminished in deference to the authority of the directorate. Yet, despite having a restricted framework to work within during the war years the science faculty successfully continued to provide teaching and research to its students and visiting evacuees.

Chapter Five – Post War Innovative Science and Academia, 1945 - 1959

Introduction

The post-war modernisation of the science faculty at the University College of Swansea is analysed in chapter five against a background of European post-war economic reconstruction. Placing the infrastructure developments at the Swansea institution in this context is important, as the destructiveness of the conflict was extensive affecting all areas and aspects of society. This section asserts that the complex set of wider associated economic, political, and social issues on an international scale put pressure on Europe and the United States for the immediate rebuilding of Europe.[991] The chapter argues that the reconstruction in Britain was inter-connected with government policies on science which was accompanied by a rising public perception of the role of science in modernising the country. The argument that the ambition underpinning government strategy on science was the expansion of scientific and technical education is explored in this section by analysing the outcome of *The Percy Report* and *The Barlow Report*.[992] Moreover, this part asserts that the connections between academia, industry and science became ever more relevant as successive governments prioritized the expansion of 'Big Science' defence research projects established during the war years.[993] The contribution of Welsh academics is explored through identifying the connections between Welsh scientists working on one of Britain's largest 'Big Science' projects, the post-war nuclear weapons programme that exemplified key elements of the term.[994]

The connection between the desire to increase the numbers of scientists and technologists, accommodating growing student numbers and improved university

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[991] John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (London: The MIT Press, 2006).

[992] *The Percy Report (1945) Higher Technical Education* (London: HMSO, 1945), www.educationengland.org.uk/documents/percy1945/percy1945.html. *The Barlow Report (1946) Scientific Man-Power* (London: HMSO, 1946), www.educationengland.org.uk/documents/barlow1946/barlow1946.html.

[993] 'Big Science' is a term used by historians and scientists when referring to the changes in scientific research during and after World War II to large-scale research projects funded by a national government or a group of governments. The term was first used by the Oak Ridge National Laboratory Director, Alvin Weinberg in his article 'Impact of Large-Scale Science on the United States' in *Science*, 134 (1961), 161-164, (p. 161).

[994] John Bayliss, *Wales and the Bomb: The Role of Welsh Scientists and Engineers in the UK Nuclear Programme* (Cardiff: University of Wales Press, 2019). Jon Agar, *Science in the Twentieth Century and Beyond* (Cambridge: Polity Press, 2012), pp. 330-332.

funding, created opportunities for academic institutions to establish building projects. Such projects were undertaken by the constituent colleges of the University of Wales. However, the chapter argues that despite the extra grant aid for the University College of Swansea there was limited new construction for the science faculty, which was due to expansion policies that were specific to the institution and pioneered by the new principal, John Fulton. The response by senior staff to the temporary measures required to deal with the inadequate teaching and research facilities are explored to highlight the pressures on the departmental communities at the Swansea institution during the post-war years. The exception to the policy of 'temporary measures' for the science faculty was the construction in the late 1950s of the permanent new building for the Natural Sciences. Furthermore, this section argues that the need to accommodate Biology and Geology and the expansion of their sub-disciplines at the science faculty was the catalyst which pushed this development in the early 1950s.

As the science faculty witnessed the departure of a significant number of its senior staff during the early post-war period, the chapter discusses how different styles of leadership influenced the structure and ethos of a department. Closely interlinked with departmental infrastructure developments were the efforts of senior scientists to raise the academic profile of their departmental communities. This process is explored in this part through identifying the increasing numbers of departmental research publications and the instigation and involvement in conferences and symposiums. Key connections were established between individual scientists and academic institutions which the chapter argues led to increasing national and transnational collaborative research projects. Therefore, the final section asserts that historic academic and industrial networks continued to be relevant during the 1950s, with senior staff exploiting their connections to establish and expand new areas of research at the institution.

Post-war economic reconstruction

In 1947, Dr R. T. Bevan, lecturer in the Hygiene and Public Health department at the Welsh National School of Medicine, started an investigation into the health and social circumstances of students at the constituent colleges of the University of Wales.[995] Bevan's report issued the following year noted the poor diet of students with cases of malnutrition, and these circumstances were exacerbated by students giving their ration

[995] Morgan, p. 71.

books to their families. The continued rationing of foodstuffs and resources in post-war Britain affected the university communities with obvious consequences for students' health.[996] As well as addressing the acute shortage of food and other household commodities, the British government urgently needed to direct its resources into rebuilding its housing stock and infrastructure.[997] However, the political and economic task of dealing with Britain's many post-war problems was formidable.[998] The intense destructiveness of World War II on the infrastructure of European countries ensured that when peace was declared in 1945 much of Europe was devastated.[999]

Swansea also suffered extensive damage during the bombing blitzes of 1940 and 1941, with the infrastructure of its central commercial area having to be completely rebuilt.[1000] Part of the financial support that was needed to support the economic transitional period from ruin to recovery in Britain and other European countries came from the United States. The role and influence of the United States in the post-war reconstruction of European science, technology and their associated institutions are assessed in the research of John Krige.[1001] Underpinning US involvement in the post-war European reconstruction was the European Recovery Programme (ERP) more commonly known as the Marshall Plan, a foreign policy initiative of George C. Marshall, secretary of state to President Truman. Marshall and others in the Truman administration recognised that a systematic programme of long-term financial aid was essential for achieving a political and economic stable Europe.[1002] Historians of economics and politics have long disagreed over the significance of the Marshall Plan, as illustrated by the different stances of the British historian Alan Milward and the American historian and political advisor Michael T. Hogan.[1003] During the 1980s both

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[996] Morgan, p. 71. For further reading on the effects of the government's rationing policy, austerity and post-war rationing see: Ina Zweiniger-Bargeilowska, *Austerity in Britain: Rationing, Controls, and Consumption, 1939-1955* (Oxford: Oxford University Press, 2000).
[997] Fred Roberts, *60 Years of Nuclear History* (Charlbury: Jon Carpenter Publishing, 1999), p. 31.
[998] Roberts, p. 31.
[999] Landes, pp. 486-495. For further reading on the history of postwar Europe see: Tony Judt, *Postwar: A History of Europe since 1945* (London: Penguin Books Ltd., 2006). Catherine Flinn, *Rebuilding Britain's Blitzed Cities: hopeful dreams, stark realities* (London: Bloomsbury, 2019).
[1000] W. C. Rogers, 'The City of Swansea' in *Swansea and its Region* ed. W. G. V. Balchin (Swansea: University College of Swansea, 1971), 317-330 (p. 325).
[1001] John Krige, *American Hegemony and the Postwar Reconstruction of Science in Europe* (London: The MIT Press, 2006).
[1002] Krige, pp. 15-21.
[1003] Andreas Frijdal, 'Alan Milward: Economic historian celebrated for his analyses of the post-war European project in *Independent* (2010), https://www.independent.co.uk/news/obituaries/alan-milward-economic-historian. Roger Adelson, 'Interview with Michael J. Hogan', in *Wiley Online Library* (2007), https://doi.org/10.1111/j.1540-6563.1999.tb01034.x.

historians published research on the European Recovery Programme, with Hogan's research defending the significance of the programme in the economic reconstruction of Europe.[1004] Yet, Milward challenged this stance arguing that ERP aid contributed only a small share of the funding for European capital.[1005]

Subsequent researchers such as Krige concluded that ERP aid helped define a vision of a prosperous future for the war-scarred Europeans.[1006] However, there was a determination within the US administration that any programmes for reconstruction had to be initiated by the European countries, with aid for prospective projects being dependent on the degree of economic integration and the marginalization of European Communist parties.[1007] This policy played out during the establishment of the political 'spheres of influence' hastened divisions within Europe: the consequences of which were the division of Germany, the establishment of NATO and an emerging Cold War.[1008] Yet, to secure transnational co-operation representatives from the 16 countries in receipt of Marshall aid created the Organization for European Economic Cooperation at the 1947 Paris meeting.[1009] A report from that original Paris meeting revealed that the economy of those countries requesting aid were previously successful with productive exports. However, 'trade, industry and agriculture had been twisted out of shape by the forces of war'. While industrial and agricultural recovery demanded scientific and technical expertise, the observations of the Bureau of Labour Statistics (BLS) noted that European scientific and technical theories on development matched that of the United States.[1010] Applying that expertise to industrial production was another matter. BLS

[1004] Michael J. Hogan, *The Marshall Plan: America, Britain and the Reconstruction of Western Europe 1947-1952* (New York: Cambridge University Press, 1987).
[1005] Alan Milward, *The Reconstruction of Western Europe 1945-51* (Berkeley and Los Angeles: University of California Press, 1984).
[1006] Krige, p. 259.
[1007] Krige, pp. 20-21.
[1008] Richard Crockatt, *The Fifty Years War The United States and the Soviet Union in World Politics, 1941-1991* (Routledge: London and New York, 1995), pp. 76-77. For further reading on the origins of the Cold War see: Marc Trachtenberg, *A Constructed Peace: The Making of the European Settlement, 1945-1963* (Princeton, New Jersey: Princeton University Press, 1999). Melvyn P. Leffler and Odd Arne Westad, eds, *The Cambridge History of the Cold War: Vol. I. Origins* (Cambridge: Cambridge University Press, 2010).
[1009] Solidelle F. Wasser and Michael L. Dolfman, 'BLS and the Marshall Plan: the forgotten story' in *Monthly Labour Review* vol 128 (2005), pp. 44-52 https://www.jstor.org/stable/i23803783 [accessed 21 September 2018], p. 56.
[1010] Wasser and Dolfman (2005), p. 44. The Bureau of Labour Statistics was established in the Department of the Interior by the Bureau of Labour Act 27 June 1884. The bureau collects information about employment and labour. Due to the unpreced44ented circumstances caused by WWII the BLS widened its remit to include foreign assistance. Wasser and Dolfman, p. 48.

studies showed that productivity levels in the United States were more than twice that of Britain.[1011]

The BLS statistical data played an increasing role in ensuring the success of the Marshall Plan and the growth of European industrial and agricultural productivity and efficiency. To deal with its expanding role the Bureau modernised and improved its statistical programmes. A development considered necessary by Isador Lubin, Commissioner of the BLS who explained:

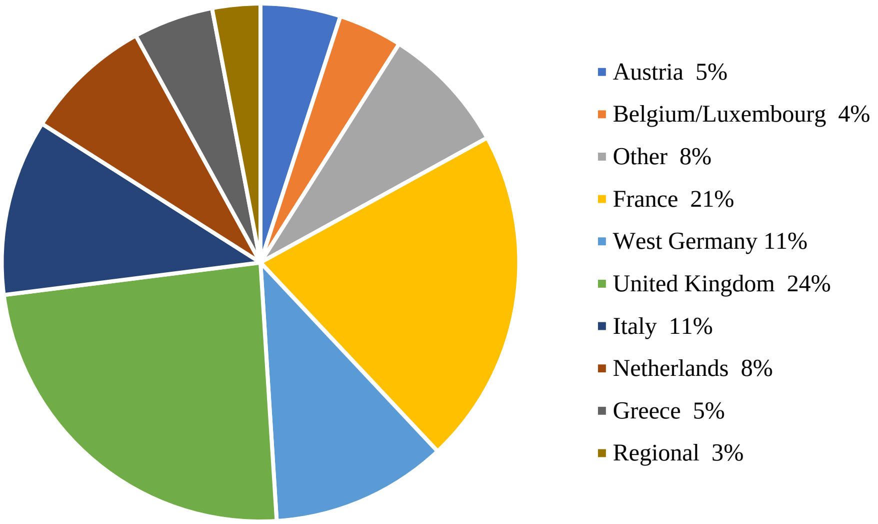
> Not only must raw data be improved but the Bureau must be enabled more fully to analyse the data it now has, so that evidence may be available as to where the recovery programme is having the greatest effect and where it is falling down.[1012]

In effect, the post-war use of statistics by the BLS in the reconstruction of Europe elevated the role of statistics as the new 'tool of science'.[1013] Furthermore, there was a political element to the ERP, which was the promotion of an independent European bloc operating a single European market.[1014] However, it was a concept that Britain was not prepared to sign up to, and as a result the creation of a European unity during this period was only a partial success. Yet, partial economic regional integration on the continent was established in 1951 with the creation of the European Coal and Steel Community, the forerunner of the European Economic Community (EEC). The ERP was actively involved with the development of this scheme.[1015]

The distribution of the Marshall Aid was a complex operation, but what is clear is that out of the European countries receiving post-war American aid, Britain was the greatest beneficiary.[1016] Britain received $2.7 billion which was almost a quarter of the total amount of the programme's aid and was a third more than the $1.7 billion received by a devastated West Germany.[1017] The differing levels of aid given to individual countries is clearly illustrated by the chart below.

[1011] Wasser and Dolfman, p. 44-48.
[1012] Isador Lubin cited in Wasser and Dolfman, p. 45.
[1013] Wasser and Dolfman, pp. 45-50.
[1014] Richard Crockatt, *The Fifty Years War. The United States and the Soviet Union in World Politics, 1941-1991* (London: Routledge, 1995), pp. 78-9.
[1015] Crockatt, p. 79. For further reading on European integration see: Vernon Bogdanor, 'Footfalls echoing in the memory. Britain and Europe: the historical perspective, *International Affairs,* 81. 4 (2005), 689-701. Jessica Reinisch, 'Roundtable Introduction: Contemporary Historians on Brexit', *Contemporary European History* 28. 1 (2019), 1-5.
[1016] Landes, pp. 486-495.
[1017] Correlli Barnett, 'The Wasting of Britain's Marshall Aid' in *BBC History* (2011), www.bbc.co.uk/history/british/modern/marshall/_01.shtml

Figure 10: Percentage of Country Allocations of Marshall Plan Aid



Reference no: Curt Tarnoff, 'The Marshall Plan: Design, Accomplishments, and Historic Significance' in *Congressional Research Service*, p. 6. [1018]

Regardless of the disproportionate size of Britain's aid package contemporary sources indicate that the positive effects of the Marshall Aid took time to filter down to the general population.[1019] A situation which was commented on in Britain's leading illustrated magazine of the time, the *Picture Post*. Summing up the year of 1947 Laurence Thompson noted the lack of the Marshall effect explaining how increasing austerity and a rising cost of living had led Prime Minister Attlee to make the alarming statement to the Commons that, 'We are engaged in another Battle of Britain'.[1020]

In addition to the theme of national austerity there was a change in social expectations at the end of the war.[1021] This was supported by increasing positive attitudes towards science, as the British public became increasingly aware of what a modern industrialized society could offer them. The British public had basic expectations of its post-war government of improved living and working standards, in addition they also expected new medical treatments and the acquisition of new media and communication technologies.[1022] As David Landes suggests this was a ' revolution

[1018] Curt Tarnoff, 'The Marshall Plan: Design, Accomplishments, and Historic Significance' in *Congressional Research Service* (2018), https://fas.org/sgp/crs/row/R45079.pdf [accessed 7 May 2019], p. 6. The 'Other' identified on the chart represents the countries of Denmark, Iceland, Norway, Portugal, Sweden and Turkey.
[1019] Laurence Thompson, '1947 Portrait of the Year', *Picture Post 1938-50* ed. by Tom Hopkinson (London: The Hogarth Press, 1984), p. 208.
[1020] Thompson, p. 208.
[1021] Hammerstein, p. 651.
[1022] Hammerstein, p. 651.

of expectations and values' which was experienced across all sections of European societies.[1023] In effect, this paradigm shift in social attitudes was a return to the optimism and expectations of the early years of industrialization, although on a greatly increased scale.[1024] These expected services and commodities were a result of scientific or technical research which was undertaken in industrial or academic settings, or a collaboration of both.[1025] Yet, the increasing public attention given to individual scientists and their research communities in the late 1940s and 1950s was an uncomfortable, and an unfamiliar situation for many scientists.[1026]

The determinants of war ensured that the conflicting pressures of secrecy and public information divided scientists into separate communities, one whose duty was to keep research secret, and another whose scientists had a duty to inform the public. However, scientists from both groups were wary of the popularization of science that was taking place during this time and many withdrew from communicating science to the public. Communicating science increasingly became the role of journalists.[1027] National newspapers created the position of the 'scientific correspondent' whose remit was to report on scientific and technological advancements and news.[1028] Journalists such as Ritchie Calder of the *News Chronicle*, John Langdon-Davies of the *Daily Mail* and the *Daily Express* journalist Chapman Pincher transmitted scientific news to the general public.[1029] In addition, the increasing role of television as the dominant medium of mass communication offered an opportunity to communicate science to a wider audience through a new type of educational forum, the television documentary.[1030] In 1957 Philip

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[1023] Landes, p. 536.
[1024] Landes, p. 536.
[1025] Sanderson, *The Universities and British Industry.* pp. 340-41.
[1026] Jane Gregory and Steve Miller, *Science in Public, Communications, Culture, and Credibility* (Cambridge: Basic Books, 1998), p. 38.
[1027] Gregory and Miller, p. 38. For further reading on communicating science see: Christoph Laucht, 'Atoms for the people: the Atomic Scientists' Association, the British state and nuclear education in the Atom Train Exhibition, 1947-1948', *British Journal for the History of Science*, 45. 4 (2012), 591-608. Sophie Forgan, 'Representations of Atomic Power at the Festival of Britain', *British Art in the Nuclear Age* ed. Catherine Jolivette (London and New York: Routledge, 2014).
[1028] Guy Ortolano, *The Two Cultures Controversy* (Cambridge: Cambridge University Press, 2009), p. 20.
[1029] Ortolano, p. 20. The scientist and intellectual Jakob Bronowski worked as a science broadcaster during the early post-war period. Bronowski's involvement in cultural scientific engagement see: Jonathan Hogg and Christoph Laucht, 'Special Issue: British Nuclear Culture' *The British Journal for the History of Science* vol. 45. 4 (December 2012), pp. 479-493. For further reading on the history of the press in the twentieth century see: Adrian Bingham and Martin Conboy, *Tabloid Century: The Popular Press in Britain, 1896 to the Present* (Oxford: Peter Lang Ltd., 2015).
[1030] Kevin Williams, *Read All About It! A History of the British Newspaper* (London and New York: Routledge, 2010), p. 175. British Film Institute Southbank, *10 Great but Forgotten TV Documentaries of the 1950s and 60s* (14 November 2016), www.bfi.org.uk>news-opinion [accessed 26 January 2020]. For

Daly produced for the BBC the first regular topical science and technology series, *Eye on Research*, which took the viewer into science laboratories and research stations.[1031] By the 1950s most households in Britain possessed a television set, thereby scientific knowledge was disseminated to a much wider audience. [1032]

The war effort had invested in new areas of technologies in medicine, energy generation, transport and communications, and new technological achievements were lauded in a growing mass media.[1033] Positive public endorsements towards science came not only from the general public but also from senior public figures such as Winston Churchill, who stated that the war could have been lost if it had not been for science.[1034] Such post-war attitudes towards the disciplines of science are supported by comments in a 1948 report by the University Grants Committee which stated:

> The part which the universities thus played in the national struggle for survival did not pass unnoticed by the public mind; and there has emerged from the war a new and sustained public interest in the universities and a strong realization of the unique contribution which they have to offer to the national wellbeing, whether in peace or war.[1035]

An awareness of scientific knowledge and its dissemination throughout the public space was made easier by an increasing organization of science projects and the groups with a vested interest in the project, notably scientific organisations, government departments and commercial publishers.[1036] Furthermore, the development of radio as the first mass medium in Britain successfully aided the circulation of scientific knowledge and news.[1037] Whether the Labour government made productive use of Marshall aid to restore the British economy is an area of contention for historians, but it is apparent that the financial aid enabled the government to develop a strategy of prioritizing exports and investment.[1038] Subsequently, there was a move away from the manufacture of

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further reading on the relationship between science and television see: Vincent Campell, *Science, Entertainment and Television Documentary* (London: Palgrave Macmillan, 2016).

[1031]BBC, *History of the BBC, Eye on Research* (6 February 2015), www.bbc.co.uk>Programmes>History [accessed 27 January 2020].

[1032] Williams, p. 175.

[1033] Gregory and Miller, pp. 36-8.

[1034] Gregory and Miller, p. 38.

[1035] UGC, *University Development from 1935 to 1948* (London: Her Majesty's Stationary Office, 1948), p. 6.

[1036] Gregory and Miller, pp. 34-8.

[1037] Gregory and Miller, pp. 34-8.

[1038] Jim Tomlinson, 'Marshall Aid and the 'Shortage Economy' in Britain in the 1940s', in *Contemporary European History* vol. 9 (2000), pp. 137-155 https://www.jstor.org/stable/20081735 [accessed 18 September 2018], p. 154.

traditional goods and declining traditional exports to the research and production of a wider range of newer products.[1039] Many of these new products were connected to the growing aircraft and motor car industries.[1040] An example being the aluminium industry whose plants were established in the Swansea region during World War II, expanded and specialised its product to cater for the car industry and aircraft businesses such as Hawker Siddeley.[1041]

The post-war aircraft industry was primarily about designing aircraft rather than building them, and like other industries during this period the military complex of research, development and production drove the industry.[1042] On the other hand, collaborative research could be initiated by research undertaken in universities as experienced by Mr. Gowenlock of the Chemistry department at the University College of Swansea.[1043] After Gowenlock's research on 'The pyrolysis of organic-metallic compounds' was published in the *Journal of the Royal Institute of Chemistry* vol. 79 (1955), it was noticed by A. Macmaster, the Air Ministry's Director of Materials Research and Development. The Director requested a copy of any relevant report, as he identified the research as a possible solution to the Directorate's problem of producing materials for aircraft that were resistant to the higher temperatures created by ever-increasing speeds.[1044] This type of specialized research was closely connected to producing highly technical goods for exportation. However, focusing production upon export rather than on consumption put immense pressure on a society where post-war austerity was increasing.[1045] During the early post-war period government rationing included food items like bread, a situation which had been avoided during the war years.[1046] An added pressure on the post-war economy was that the defence expenditure stood at the wartime level of one-fifth of the GNP.[1047] By the 1950s the defence expenditure rose sharply partly due to rearming and updating the armed forces and

[1039] Landes, p. 495.
[1040] Sanderson, p. 71.
[1041] Grahame Humphreys, 'Manufacturing and Service Industries' in *Swansea and its Region*, ed. by W. G. V. Balchin (Swansea: University College of Swansea, 1971), 255-272 (p. 266).
[1042] David Edgerton, *Warfare State Britain, 1920-1970* (Cambridge: Cambridge University Press, 2006), p. 102.
[1043] RBA, reference no: UNI / SU / AS / 2 / 1 / 540, A Macmaster, Air Ministry of Supply, *Letter to the Registrar* (1955).
[1044] RBA / UNI / SU / AS / 2 / 1 / 540, Macmaster (1955).
[1045] Robert Bud and Philip Gummett, 'Introduction: Don't You Know There's a War On', in *Cold War Hot Science* ed. by Robert Bud and Philip Gummett (London: NMSI Trading Ltd, 2002), p. 7.
[1046] Bud and Gummett, p. 7.
[1047] Bud and Gummett, pp. 7-8.

supporting troops stationed abroad and the government's commitment to unprecedented large-scale R&D projects.[1048] However, unable to compete with its foreign competitors in the technological advances made in the commercial and military sectors the British government was pressured to address inadequacies in its tertiary education system. [1049]

State Science Policies and the development of post-war science research communities

While the British government realised that post-war re-construction was reliant on ensuring the future support of academic and commercial science, those scientists working within academia were aware of the limitations of their institutions. As with many colleges and universities any plans for expansion at the University College of Swansea had been halted by the outbreak of war.[1050] Senior scientific staff at the Swansea institution stated in various post-war reports that their departments had inadequate teaching and research space and equipment, and were ill-equipped to deal with departmental expansion and increasing student numbers.[1051] To add to these difficulties there was also limited access to the two secretarial staff which were pooled between seven departments, a situation that the head of Chemistry, Professor Shoppee described as 'wholly inadequate'.[1052] Shoppee was not alone in his views on the inadequacy of secretarial support which he deemed to be an absolute necessity for dealing with the bureaucracy of re-organising and expanding departments. In a collaborative letter with L. J. Kastner from the Engineering department to the Dean of the Faculty of Science, Shoppee urged appointing a fulltime secretary for each department.[1053] To aid the expansion and modernisation of science departments at the Swansea institution, as well as supporting commercial science the government initiated

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[1048] Edgerton, pp. 100-05.
[1049] Argles, p. 138. For a contemporary report on post-war university requirements see: British Association for the Advancement of Science, *Post-War University Education* (London: BAAS, 1944).
[1050] Frank Tyrell, *The* Story *of the City of Swansea* (Swansea: the author, 1969), p. 39.
[1051] RBA, reference no: UNI / SU / AS / 2 / 1 / 358, Frank Llewellyn Jones*, Report on the Immediate and Post-War needs of the Department of Physics* (1946). reference no: UNI / SU / AS / 2 / 1 / 390, C. W. Shoppee, *Memorandum on Laboratory Accommodation in the Chemistry Department* (1948). reference no: UNI / SU / AS / 2 / 1 / 407, *Report on Staffing Requirements in Geology and Geography Departments* (1948). reference no: UNI / SU / AS / 2 / 1 / 407, F. Llewellyn-Jones, *Staffing Needs for the Remainder of the Quinquenium, 1949-1952.*
[1052] RBA, reference no: UNI / SU / AS / 2 / 1 / 407, C. W. Shoppee, *Letter to Registrar, E. Drew* (5 November 1948).
[1053] RBA, reference no: UNI / SU / AS / 2 / 1 / 407, C. W. Shoppee, L. J. Kastner, *Letter to the Dean of the Faculty of Science* (11 January 1949).

policies and allocated the required funding.[1054] The government commissioned two reports to assess what steps were needed to create an environment that encouraged an increase in the numbers of trained specialists.[1055] Out of these committees came *The Percy Report* (1945) and *The Barlow Report* (1946) which determined the part that education could play in providing the necessary increase in highly trained scientific and technological manpower.[1056] The *Percy Report* dealt with issues relating to the provision of technical education in England and Wales, especially issues pertinent to educational collaboration between universities and Technical Colleges in meeting the requirements of industry.[1057]

To ensure that collaboration took place the Ministry of Education divided England and Wales into ten areas, with each area having a Regional Advisory Council for Further Education and a Regional Academic Board.[1058] Teaching representatives from both universities and technical colleges from within each region sat on the Regional Academic Boards.[1059] An equally important aspect of the *Barlow Report* was that it concentrated on the policies that were deemed necessary to encourage a period of university expansion, especially in relation to the sciences. The report was not only fundamental in shaping government policy to expand the provision of science higher education but was the first stage of a process which led to the Robbins Report in 1963.[1060] The *Barlow Report* also recorded that the restrictions placed on the areas of scientific research that were undertaken during the years of conflict of World War II had a detrimental effect on the area of basic research.[1061] Therefore, while the advancement of both basic and applied science was deemed to be essential, the Barlow committee urged that re-establishing basic science research must be a priority.[1062] This was the British attempt to re-establish the orthodox practice of offering a firm foundation in pure scientific research, a move which was repeated in other Western European

[1054] Krige, p. 38.
[1055] Maclure, p. 230.
[1056] The Percy Report, *Higher Technical Education* (London: HMSO, 1945), www.educationengland.org.uk/documents/percy1945/percy1945.html. The Barlow Report, *Scientific Man-Power* (London: HMSO, 1946), www.educationengland.org.uk/documents/barlow1946 .
[1057] Maclure, pp. 226-30.
[1058] Berdahl, p. 98.
[1059] Berdahl, p. 98.
[1060] Maclure, p. 230.
[1061] Report of a Committee appointed by the Lord President of the Council, *The Barlow Report, Scientific Manpower* (London: HMSO, 1946), p. 19.
[1062] The Barlow Report, p. 19.

countries.[1063] Research in applied physics was particularly dominant during World War II, so much so that the conflict has been called a war of physics.[1064] The Barlow Committee discussed how the uncertainties around university funding, especially the inconsistencies of private funding had a detrimental effect on university expansion.[1065]

To realistically move forward with university development the Barlow Committee stated that university funding should mainly come from the Exchequer.[1066] In the immediate post-war years the University Grants Committee played a key role in supporting universities primarily by awarding an unprecedented amount of capital funds, as well as approving the release of scarce labour and materials for university building projects.[1067] Industrial growth was a crucial area that required assistance, particularly with the difficulties of increasing the numbers of highly trained scientists and technicians.[1068] Again, state involvement was facilitated by the U.G.C. who by expanding its role to liaise with other governmental agencies such as the Ministry of Education, the Ministry of Agriculture, the Department of Scientific and Industrial Research and other research councils, widened the debate on university education. All these groups could appoint assessors who were entitled to attend the meetings of the U.G.C., although not in a voting capacity.[1069]

The pattern of militarised large-scale collaborative science projects which developed during the war would be strengthened and extended by the demands of the Cold War.[1070] In his comprehensive research on science in the twentieth and twenty-first centuries Jon Agar notes how the undertaking of scientific research had changed. Expressing the view of an academic administrator from 1953 that; 'The scale of research and the complexity of its techniques have grown beyond anything imagined a few decades ago…' was due mainly to the war. Agar discusses the argument proposed by Paul Forman that post-war, huge amounts of military funding shaped the quantity and direction of science of the emerging Cold War. Forman's argument is supported by

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[1063] Peter J. Bowler and Iwan Rhys Morus, *Making Modern Science A Historical Survey* (Chicago: The University of Chicago Press, 2005), p. 484.
[1064] Sanderson, *The Universities and British Industry*, p. 347.
[1065] The Barlow Report, p. 11.
[1066] The Barlow Report, p. 11.
[1067] Berdahl, p. 80.
[1068] Maclure, p. 230.
[1069] Berdahl, p. 80.
[1070] Agar, pp. 308-10. For further reading on the history of large scientific projects see: Derek J. De Solla Price, *Little Science, Big Science…Beyond* (Columbia: Columbia University Press, 1986). Peter Galison and Bruce Hevly (eds.), *Big Science: The Growth of Large-Scale Research* (Stanford: Stanford University Press, 1992).

other historians, but his proposal that militarization shaped physical knowledge is disputed. While Forman's research is directed at the situation in the United States, there are parallels with the organisation of aspects of post-war science in Britain.[1071]

The post-war British nuclear weapons and nuclear power programmes were an example of a complex, interconnected military and industrial research programme supported by ever-increasing amounts of funding.[1072] Yet, in the early years of World War II atomic physics research was undertaken completely in the university laboratory space such as the Cavendish Laboratory, Cambridge, Imperial College and Birmingham.[1073] The involvement of industrial firms and their chemists came later and included dominant firms such as General Electric Company, British Thompson-Houston, Imperial Chemical Industries, EMI Group Ltd. and Metro-Vickers. While these leading commercial firms had moved away from relying on university-based research and established their own major research centres and laboratories during the inter-war years, the pressures of war fostered new connections with university physics departments. The scientists of these new research communities worked on the practical and the theoretical problems of radar and atomic energy, with some individuals even working on both projects.[1074]

In order to understand the involvement of Welsh scientists and the University College of Swansea in the post-war nuclear weapons programme, this section of the chapter briefly looks at the early years of the atomic bomb programme. Imperial Chemical Industries (ICI) was connected to the highly secret British atomic bomb project known as 'Tube Alloys' through the deployment of their executive manager Wallace Akers (1888-1954) as director of the project.[1075] The research of Michael Sanderson identifies those universities which established connections and developed specific new research projects with industry throughout the period of World War II.[1076]

[1071] Agar, p. 319.
[1072] Roberts, p. 30-31.
[1073] Sanderson, *The Universities and British Industry*, pp. 343-47. For further reading on atomic research see: Margaret Gowing, *Britain and Atomic Energy, 1939-1945* (London: Palgrave Macmillan, 1965). Christoph Laucht, *Elemental Germans Klaus Fuchs, Rudolf Peierls and the making of British Nuclear Culture 1939-59* (London: Palgrave Macmillan, 2012).
[1074] Sanderson, *The Universities and British Industry*, p. 347.
[1075] Sally M. Horrocks, 'The Royal Society, its Fellows and Industrial R&D in the mid Twentieth Century' in *Notes and Records of the Royal Society* vol. 64 (2010), 31-41 https://www.jstor.org/stable/20753920 [accessed 29 April 2018], p. 34.
[1076] Sanderson, *The Universities and British Industry*, pp. 341-48. For further reading on science and its place in society see: James Chapshew and Karen Rader, 'Big Science: Price to the Present', in Science after' 40, ed. by Arnold Thackray (*Osiris*, 2nd series, 7 (1992), pp. 2-25.

Sanderson concludes that these collaborations were uniquely connected to English universities, suggesting that the need for secrecy and close collaboration between researchers during severe war-time travel disruption cancelled out locating research centres in Wales or the north of the country.[1077] While the constituent colleges of the University of Wales did not take part in war-time scientific research projects as an institution, the colleges' scientific staff and post graduate students joined these war-time research communities.[1078] A number of these Welsh scientists continued collaborating with particular research projects in the post-war years as they evolved into major national programmes. The most notable of these was the development of the British atomic and thermonuclear programme.[1079] In 1945 a top-secret cabinet meeting of the British coalition government made the decision that it was necessary to build an atomic pile large enough for the annual production of 15 nuclear bombs.[1080] Yet, Parliament was only informed in a quiet way during a parliamentary question by A. V. Alexander, Ministry of Defence on 12 May 1948.[1081]

Ieuan Maddock (1917-1988), a physics graduate who specialised in optical measurements played a key role in these research programmes, as did two other Welsh scientists who had graduated from the University of Wales.[1082] David Lewis (1909-1992) obtained his BSc and PhD Chemistry degrees at Aberystwyth University College, while Graham Hopkin trained as a metallurgist at Cardiff University College.[1083] While Maddock, Lewis and Hopkin's post-war research would make a significant contribution to the development of the British H-Bomb, there were also many other Welsh scientists who worked on the project.[1084] Wartime conditions restricted the research choices of many scientists and postgraduate students such as Maddock, for whom the war

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[1077] Sanderson, *The Universities and British Industry*, p. 348.
[1078] Richard Burton Archives, reference no: Box no: 2014 / 20 / 5 (uncatalogued) W. M. Jones, *One Hundred Years of Physics at University College of Wales Aberystwyth* (2nd draft), p. 87.
[1079] Lorna Arnold and Mark Smith, *Britain, Australia and the Bomb. The Nuclear Tests and their Aftermath* (Basingstoke: Palgrave Macmillan, 2006), pp. 1-10.
[1080] Fred Roberts, *60 Years of Nuclear History* (Charlbury: Jon Carpenter Publishing, 1999), pp. 26-9.
[1081] Roberts, p. 29.
[1082] Steffan Rhys, 'Welshmen who worked with the Father of the British Bomb', *Online Wales* (31 March 2010), https://www.walesonline.co.uk [accessed 7 October 2018]. For further reading on the involvement of Welsh scientists with the atomic bomb programme see: John Baylis, *Wales and the Bomb: The Role of Welsh Scientists and Engineers in the UK Nuclear Programme* (Cardiff: University of Wales Press, 2019).
[1083] Mansel Davies, *Obituary: D. T. Lewis* (1992), https://www.independent.co.uk>News>People [accessed 8 October 2018].
[1084] Mary Auronwy James, 'Maddock, Sir Ieuan (1917-1988), Chief Scientist to the Department of Industry' in *Dictionary of Welsh Biography* (2012), http://yba.llgc.uk [accessed 25 September 2018]. Lorna Arnold, *Britain and the H-Bomb* (Basingstoke: Palgrave, 2001), p. 73. Rhys (2010).

disrupted his postgraduate research.[1085] However, the wartime environment offered new research choices as well as promotional opportunities for many scientists. The outbreak of World War II enabled David Lewis to leave his low paid job as a Chemistry teacher at a Grammar School in the small village of Quakers' Yard, in Mid Glamorgan, when he was recruited by the Ministry of Supplies Armament Division.[1086] Lewis quickly achieved promotion to the level of scientific officer and his research with explosives led to an appointment with the physicist, William Penney's research team as superintendent of the chemistry division.[1087]

During the war years William Penney had led the British delegation which worked on the joint American, Canadian and British atomic weapons programme, the Manhattan Project, and in 1947 he was directed to establish Britain's atomic weapons programme.[1088] Assembling a hand-picked team of scientists, Penney described Lewis as his second cleverest scientist (the cleverest being the mathematician John Corner), commenting that; 'He (Lewis) works harder and faster than any other chemist in the establishment, and his staff are inspired by his example.'[1089] Wartime disruption led to Maddock working as an experimental officer with the Department of Explosives Research and Development, a government department which had been evacuated to the Swansea institution. Maddock's subsequent move in 1944 to the Armament Research Department at Fort Halstead cemented his career, as his work on the instrumentation of conventional explosives continued with the instruments for nuclear explosives.[1090] Maddock's career took him to the centre of British atomic research in 1949 when he was headhunted by William Penney to lead the Atomic Weapons Research Establishment at Aldermaston. The work of Maddock and his research group would take them to Australia where they would provide key measurements for the successful detonation of the first test of a British atomic device on the Monte Bello Islands on 3 October 1952. On a lighter note, as Maddock oversaw the countdown to the detonation codenamed *Hurricane* it earned him the nickname 'The Count of Monte Bello'.[1091]

1085 Neville Evans, 'Scientists of Wales: Ieuan Maddock, F.R.S.', *Cymru Culture* (2014), http://www.cymruculture.co.uk/featuredarticles_91017.html [accessed 21 October 2016].
1086 Davies.
1087 Davies.
1088 Arnold, p. 72. Agar, p. 309. For further reading on the Manhattan Project see: Jeff Hughes, *The Manhattan Project: Big Science and the Atom Bomb* (Cambridge: Icon Books Ltd., 2002).
1089 Arnold, pp. 72-3.
1090 James.
1091 James.

The *Hurricane* test had implications for the British atomic research community which had been established mainly to push through the development of an operational nuclear weapon.[1092] Implementing a nuclear weapons programme was a key element in the British post-war defence policy of attempting to maintain a strong presence in the New World order of superpowers.[1093] The success of the test ensured that a new period of research and development was established, with the substantial data collected from the test being scrutinized.[1094] This culminated in dozens of scientific reports which had implications for military, civil defence, biological research, as well as valuable information on radiation and methods on decontamination. On another level the report by the liaison officer, Captain Pat Cooper provided an assessment of the problems and difficulties that occurred during the planning and aftermath of the test, thereby providing an important analysis for the future planning and administration of further tests.[1095]

The pressure put on the government with regard to the urgency of increasing the number of qualified scientists in the *Barlow Report* was clear: 'Never before has the importance of science been more widely recognised or so many hopes of future progress and welfare founded upon the scientist'.[1096] With secure future funding the committee suggested that university expansion should double the annual output of qualified scientists from 2,500 to 5,000 a year, with the total number of scientists increasing from 60,000 to 70,000 by 1950 and 90,000 by 1955.[1097] The doubling of science and technological graduates was achieved in five years, not ten.[1098] This impressive achievement was matched by the Arts as the overall student population was increased by 80% in two years, an increase noted in a 1948 UGC Report: 'The desired increase of numbers (students) by about 80% within a decade can only be described as revolutionary'.[1099] However, this rapid increase in student numbers created practical pressures. Overall, universities were successful in overcoming problems of staff shortages and limited building space with the support of generous grants from the

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1092 Arnold and Smith, pp. 29-32.
1093 Bud and Gummett, pp. 7-8.
1094 Arnold and Smith, pp. 46-7.
1095 Arnold and Smith, p. 47. Captain Pat Cooper was also the technical aide to William Penney.
1096 The Barlow Report, *Scientific Manpower* (London: HMSO, 1946), www.educationengland.org.uk/documents/barlow1946 [accessed 06 December 2018], p. 2.
1097 Sanderson, *The Universities and British Industry*, p. 349.
1098 Sanderson, *The Universities and British Industry*, p. 351.
1099 Ernest Simon, 'Student Numbers 1911 to 1971' in *The Creation of a University System*, ed. by Michael Shattock (Oxford: Blackwell Publishers, 1996), pp. 47-8.

government to provide these extra university places. A number of these placements were for ex-service men who had their university careers disrupted by the war.[1100] In 1946 the British Admiralty urged universities to reserve places and allow late enrolment for overseas naval officers who on their release of service wished to continue or start university.[1101]

The number of ex-service personnel who entered into the university system post-war were of large enough numbers to create a temporary distortion in the official data of student numbers in the 1940s.[1102] However, not all ex-service personnel wishing to enrol in British universities were from the British military as revealed by primary source evidence in the archives at Swansea University.[1103] American service men and women who had been in university when the United States entered the war also had their university studies interrupted. The Minister of Labour and the Swansea University College authorities arranged for approximately 75 American and Canadian military personnel to continue with their academic studies at the institution. The organisational work-load of reserving and allocating the required places on the desired courses was of concern to the departmental heads.[1104] These concerns were misplaced as the accelerated repatriation of Canadian Army men and women meant that many of these reserved university places were not needed.[1105] However, American servicemen did take up their allocated places with four attending first and second year courses in Biology and seven joining the Chemistry department.[1106] Returning servicemen to the United States were helped to restart their studies with benefits provided by the Servicemen's Readjustment Act of 1944, otherwise known as the G.I. Bill.[1107]

The inclusion of overseas and national ex-servicemen and women in the student population changed the make-up of this socio-group. The maturity of these students in the post-war academic sessions are evident in pictorial sources, as illustrated in the

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[1100] Simon, p. 49.
[1101] RBA, UNI / SU / AS / 2 / 1 / 370, Secretary to the Admiralty, *Letter to the Principal* (1946).
[1102] Sanderson, *The Universities and British Industry*, p. 351.
[1103] RBA, reference no: UNI / SU / AS / 2 / 1 / 354, Principal Edwards, *Internal memo sent to Heads of Departments on registration of American and Canadian soldiers* (20 September 1945).
[1104] RBA, UNI / SU / AS / 2 / 1 / 354. For further reading on Us forces in Britain during World War II see: David Reynolds, *Rich Relations: the American Occupation of Britain, 1942-1945* (London: Pheonix Press, 1996).
[1105] RBA, UNI / SU / AS / 2 / 1 / 354, H. F. E. Smith Lt. Colonel, Director of Extension Khaki University of Canada, *Letter to the Registrar* (18 September 1945).
[1106] University College of Swansea, 'Reports of Heads of Departments for the Year ended 30 September 1946' in *Annual Reports* (1935-1946), pp. 3-6.
[1107] Olson, Keith W., 'The G.I. Bill and Higher Education: Success and Surprise' *American Quarterly,* 25. 5 (1973), 596-610 (p. 609).

archived photographs of students at Swansea University College during this period.[1108] The return of American ex-service personnel back to the United States did not end the post-war association of American students with British universities. An association was established which was closely connected to the American aid programme, the Marshall Plan.[1109] As a 'thank you' from the British government for this aid the Marshall Aid Commemoration Commission was established to financially support American scholars who wished to study in Britain. In 1953 the Association of Commonwealth Universities took on the role of managing the scholarship funds of the programme.[1110] While studying in Britain overseas students were supported by the British Council, especially in relation to procuring suitable and affordable accommodation.[1111] Finding accommodation was particularly difficult for certain students due to racist attitudes in Britain, as illustrated by the 1,500 university approved landladies in Edinburgh of whom only 300 would accommodate non-white students during in the 1954-55 academic session.[1112]

Similar attitudes were prevalent in Wales, although the official stance from the University of Wales was that the institution worked closely with the British Council to accommodate most overseas in the halls of residence.[1113] A report on a survey of male student's lodgings in Swansea compiled in 1955 by Dora Herbert Jones (1890-1974), the institution's career officer recorded a different picture. Jones was an impressive and pioneering administrator who during her career had worked as secretary to John Herbert Lewis, the M.P. for Flintshire, and during the election of 1918 was the election agent for a candidate for the University of Wales seat, Herbert Lewis.[1114] By taking on these jobs Jones had made pioneering steps for the role of women in administration as her first position in 1913 made Jones the first woman to work in the House of Commons, and her role as an election agent was the first time in Britain that a women had achieved this

[1108] RBA, reference no: UNI / SU / AS / 4 / 1 / 1, no. 10, *Photographs of Students at Swansea University College*.
[1109] John Kirkland and Nicholas Mulhern, 'From 'Imperial Bureau' to 'International Network', 1913-2013' in *Universities for a New World* ed. by Deryck M. Schreuder (London: SAGE Publications Ltd., 2013), p. 71.
[1110] Kirkland and Mulhern (2013), p. 71.
[1111] RBA, reference no: UNI / SU / AS / 2 / 1 / 524, Registrars' Conference, Minutes of Conference of Registrars (6 April 1955), pp. 6-7.
[1112] RBA / UNI / SU / AS / 2 / 1 / 534, *Registrars' Conference* (1955), pp. 6-7.
[1113] RBA / UNI / SU / AS / 2 / 1 / 534, *Registrars' Conference* (1955), pp. 6-7. UNI / SU / AS / 2 / 1 / 565, Dora Herbert Jones, *Report on Survey of Men's Lodging undertaken in the Summer Term* (1955).
[1114] Gwenan Gibbard, 'Dora Herbert Jones 1890-1974' in *Transactions of the Honourable Society of Cymmrodorion* vol. 12 (2006), https://www.cymmrodorion.org [accessed 26 November 2018], p. 123.

political position.[1115] Jones's report on male students accommodation concluded that providing suitable accommodation for overseas students in Swansea was a serious problem, with racism being an issue.[1116] In addition, Jones deduced that the British Council was too centralised as an organisation to be effective for specific individual cases at a local level.[1117] Furthermore, rising student numbers during the 1950s compromised the limited student accommodation in the halls of residence at the Swansea institution. [1118]

The end of an Era: Departmental Leadership and connections with 'Big Science'

As well as a change in the demographics of the student population, the early post-war years witnessed a change in the academic leadership for the University College of Swansea. There was not only the retirement in 1947 of the Principal, Professor Edwards, but also the departure of heads of the Chemistry, Physics and Metallurgy departments.[1119] Edwards was succeeded by John Scott Fulton (1902-1986), a lecturer in Philosophy, who had gained administrative experience as principal assistant secretary in the mines department and in the Ministry of Fuel and Power during the Second World War.[1120] The appointment of Fulton was a distinct break by the college authorities from employing a research scientist for the post of principal. The careers of the two previous principals, Sibly and Edwards, were science-based, and their expertise in their respective disciplines of Geology and Metallurgy influenced departmental research. Fulton's main interests were in the development of adult education and the social sciences, but it would be his predilection towards university expansion that would benefit the science faculty.[1121] The major part of the expansion which addressed the needs of the science faculty was the construction of a permanent building to house the natural sciences of Botany, Zoology, Geology and Geography.[1122] The plans for the building were drawn up in 1953 by Sir Percy Thomas, but the initial concept of the proposed new build originated with Professor Mockeridge in a college report of

1115 Gibbard, p. 123.
1116 RBA / UNI / SU / AS / 2 / 1 / 565, Jones (1955).
1117 RBA / UNI / SU / AS / 2 / 1 / 565, Jones (1955).
1118 Dykes, pp. 159-162.
1119 Morgan, pp. 58-9.
1120 Oxford Dictionary of National Biography, *Fulton, John Scott, Baron Fulton (1902-19860)* (2004), https://doi.org/10.1093/ref:odnb/39987 [accessed 7 September 2018].
1121 Oxford Dictionary of National Biography, https://doi.org/10.1093/ref:odnb/39977. Morgan (1997), p. 59.
1122 H. E. Street, 'University College of Swansea New Science Laboratories' in *Nature,* vol. 179, p. 124.

1925.[1123] The analysis of that development in its context of departmental expansion will be discussed later in the chapter.[1124]

As well as adapting to the change in the leadership of the university college, the science faculty had to also adjust to the change of key personnel in the departmental communities of the Physics, Chemistry and Metallurgy departments. A vital component of the process of creating the close-knit teaching and research communities that were established during the pre-war decades was longevity of service. The departmental heads, Professors Coates, Evans and Edwards had been with their departments since the establishment of the university college in 1920 and had proceeded to build-up their departments *ab initio*. All three scientists had a profound influence on the success of the departments and the direction of research undertaken in their respective laboratories. Equally, within these departments there were some long serving members of staff who had spent their careers working at the Swansea science faculty. One such individual was Dr Hinkel who had joined the Chemistry department in 1920 during the institution's first session as Senior Lecturer. Hinkel worked closely with Coates for twenty-seven years and then chose to retire at the same time as Coates in 1947.[1125] The assistant lecturer Dr Hartshorne also left the department in the same year as his senior colleagues to take up an appointment at Leeds University.[1126] Although the Chemistry department was well established by this period, the departure of two long-serving key members of staff initiated changes in the direction of research within the department.[1127]

A similar set of circumstances affected the Physics and Metallurgy departments. As noted earlier, Principal Edwards retired in 1947 and this meant that his headship of the Metallurgy department also came to an end.[1128] Edwards's departure from the university college gave an opportunity for the Metallurgy department to have yet again a departmental head whose sole responsibility was the administration and development of the department. While this is not a criticism of Edwards's performance during his headship, it is clear from the institution's Annual Reports that Edwards' responsibilities

[1123] Richard Burton Archives, Swansea University, File no: UNI / SU / AS / 2 / 1 / 79, *Reports by Heads of Departments with reference to the future needs and projects of the College* (13 March 1925)
[1124] Morgan, p. 52.
[1125] West Glamorgan Archives, File no: D/D UCS, University College of Swansea, reference no: 1/1, *Annual Reports of Council* (1920), p. 4. Swansea University Library Pamphlets, Box no. LF1200 – LZ, reference no. LF 1229, E. E. Ayling, *Schools of Chemistry in Great Britain and Ireland. XXI – University College, Swansea* (Reprinted from Journal of the Royal Institute of Chemistry, December 1955), p. 626.
[1126] SULP / LF 1229, Ayling (1955), p. 626.
[1127] Ayling, pp. 626-628.
[1128] Ayling, p. 626.

as Principal overshadowed his duties as head of department.[1129] However, Edwards' duties as a Principal did not prevent him from directing research projects. Consequently, during his time at the university college Edwards published individually or jointly twenty-eight research papers which related to mild steel and tinplate production, the influence of heavy cold rolling on the final mild steel sheet structure and definitive work on the structure of steel ingots.[1130]

The situation that initiated a change of the head of the Physics department was of a different nature to that of the Chemistry and Metallurgy departments. The death of the head of the Physics department Professor Evans after becoming ill at the beginning of January 1943, enabled the college authorities to offer an opportunity to a long serving member of the Physics staff Frank Llewellyn Jones (1907-97).[1131] Even though the appointment was an internal appointment the numerous applications that were received for the post from across the world were evidence to the Physics department's growing reputation.[1132] Applications were received not only from physicists working in academic and military across Britain, but from South Africa and Australia as well.[1133] Such wide interest in a headship in a small department is down to the efforts of Professor Evans, who during his time at the Physics department had been successful in building up the national reputation of a department, which placed great emphasis on directing the training of its students in the methods of research.[1134]

The effectiveness of Evans's approach of prioritising the teaching of research methods with his students was highlighted by the high number of Physics graduates who achieved impressive work in the discipline of Physics. For just over two decades Physics students who studied at the University College of Swansea were part of a teaching and research community which shaped their identity as scientists. Evans was

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1129 L. b. Pfiel, 'Charles Alfred Edwards 1882-1960' *in Biographical Memoirs of Fellows of the Royal Society*, vol. 6 (1960), pp. 32-38 http://www.jstor.org/stable/769332 [accessed 13 March 2017], p. 35.
1130 Donald Walter Hopkins, 'Edward, Charles Alfred (1882-1960), metallurgist and principal of University College of Swansea' in *Dictionary of Welsh Biography* (2001), http://yba.llgc.org.uk [accessed 30 April 2018], pp. 36-37. Edwards research on steel ingots: 1933 (With H. N. Jones) A study on the influence of varying oxygen and carbon content in iron upon the position of blow-holes in steel ingots Fifth Report on the Heterogeneity of Steel Ingots, Section V. *Iron & Steel Inst. Special Reports*, No. 4, 39-58. 1935 (With K. Higgins, M. Alexander and D. G. Davies). The influence of casting temperatures upon the position of blow-holes in steel ingots of varying oxygen and carbon content. Sixth Report on the Heterogeneity of Steel Ingots, Section XI. *Iron & Steel Inst. Special Reports*, No. 9, 193-218.
1131 Richard Burton Archives, reference no. Box no. 666 (bundle 3 of 4), L. Wright, *The Department of Physics 1922-1945* (unpublished), p. 10.
1132 RBA, UNI / SU / AS / 2 / 1 / 334, *Testimonials for post of Head of Physics Department.*
1133 RBA / UNI / SU / AS / 2 / 1 / 334.
1134 Dykes, p. 126.

an expert in spectroscopy and his influence in this field inspired many of his graduates to pursue careers in this area of Physics, one of the most significant was William Charles Price (1909-1993).[1135] Price's career as a spectroscopist spanned over four decades and involved him in wartime research at I.C.I. as well as academic research posts at the Physical Chemistry Laboratory, Cambridge, the University of Chicago (1946-7) as a Research Associate in Molecular Spectroscopy, and from 1948 to 1976 as the Wheatstone Chair of Physics at King's College London. Price was made a fellow of the Royal Society in 1959, however his pioneering work covering the three branches of spectroscopy, ultraviolet, infrared and photoelectron, were so comprehensive that the spectroscopic and chemical physics communities believed it merited a Nobel Prize. This was an honour he never received.[1136]

Another physics graduate who was in the same honours class as Price, and whose research would grant him a Royal Society fellowship was Edward George Bowen (1911-1991).[1137] Bowen was the son of a Swansea tinplate worker, and his parent's financial circumstances entitled him to a scholarship and this enabled Bowen to study physics at Swansea University College. Bowen was fully supported by Dr W. Morris Jones and Professor Evans in his post-graduate research on X-rays and alloys. However, it was Evans who recognised Bowen's passion for radio and arranged for him to undertake a PhD under the supervision of a pioneer in 'radio physics', Professor E.V. Appleton (1892-1965).[1138] Bowen (known as 'Taffy') went on to have a complex and successful career, which was summed up by John Paul Wild (1923-2008) who succeeded Bowen as Chief of Division of the Radiophysics Laboratory in Sydney:

> The world will remember Taffy firstly as a member of the three-man team that developed radar to help save the day for Britain in 1940 – secondly as the dynamic post-war leader of the Radiophysics Laboratory: and thirdly as the engineer who brought to successful completion two major astronomical instruments of his era.[1139]

Bowen's collaborative research with Joseph L. Pawsey (1908-1962) at the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research

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[1135] R. N. Dixon, D. M. Agar and R. E. Burge, 'William Charles Price. 1 April 1909-10 March 1993', *Biographical Memoirs of Fellows of the Royal Society*, vol. 43 (1997), 430-442, https://www.jstor.org/stable/770344 [accessed 12 October 2018], p. 432.
[1136] Dixon, Agar and Burge, pp. 434-440.
[1137] Dixon, Agar and Burge, p. 433.
[1138] J. A. Ratcliffe, 'Edward Victor Appleton, 1892-1965', *Biographical Memoirs of Fellows of the Royal Society*, vol.12 (1966), rsbm.royalsocietypublishing.org [accessed 14 October 2018].
[1139] Ratcliffe, pp. 16-17.

Organisation (CSIRO) in Australia developed into the discipline of radio astronomy.[1140] This was one of the major post-war ‘Big Science’ projects involving radio astronomy that were being undertaken in industrialized countries such as Australia and the USA.[1141]

As well as Bowen, Maddock and Price, three other students of Evans went on to become Fellows of the Royal Society, Granville Beynon (1914-1996) John Beynon (1923-2015) and Evan Williams (1903-1945).[1142] Williams, Granville Beynon and John Beynon pursued academic careers within Welsh institutions, with Williams becoming Professor of Physics at Aberystwyth University College in 1938.[1143] Williams worked closely with the Air Force and the Navy during the war years as scientific advisor to both military forces, with his research making important contributions to the winning of the U-Boat war.[1144] Tragically, Williams’ career was cut short with his untimely death in 1945.[1145] In contrast, John Beynon spent the first 22 years of his career undertaking most of his research in the industrial environment.[1146] While specialising in spectrometry with Imperial Chemical Industries where Beynon constructed the first mass spectrometer which analysed organic compounds, he also held a Professorship at Purdue University in 1968.[1147]

The details of Beynon’s career puts him in the company of the few twentieth-century scientists whose careers spanned numerous posts in academia as well as industry or government research establishments.[1148] The important research undertaken by Beynon and the other scientists at the University College of Swansea reveal the post-war growth of the college in the scientific teaching and research offered by the institution. Furthermore, the details of their careers illustrate how the longevity of staff appointments was still commonplace at the science faculty. In an oral history interview conducted with Beynon in 2008, he explained that in his desire to return to his alma

[1140] Agar, p. 368.
[1141] Agar, p. 368.
[1142] Dykes, p.126.
[1143] Griffith Milwyn Griffiths, ‘Williams, Evan James (1903-1945), scientist’ *Dictionary of Welsh Biography* (2001), http://yba.llgc.uk [accessed 9 September 2018].
[1144] P. M. S. Blackett, ’Evans James Williams 1903-1945’ *Obituary Notices of Fellows of the Royal Society* vol. 5 (1947), 386-406, https://www.jstor.org/stable/i231369 [accessed 16 October 2018], pp. 388-89.
[1145] Blackett, p. 388.
[1146] Graham Cooks, ‘John H. Beynon (1923-2015)’ *Journal of the American Society for Mass Spectrometry* vol. 27 (2016), 561-562 (p. 561).
[1147] Cooks, p. 562.
[1148] Horrocks, p. 36.

mater, Swansea University after his retirement he negotiated with the Royal Society for a position and funding.[1149] Consequently, in 1974 the Mass Spectrometry Research Unit was set up at the institution with Beynon as its Royal Society Research Professor and Director with complete autonomy over expenditure and the direction of research.[1150] However, Beynon's coup of obtaining a Royal Society research chair for the university college at Swansea, an award that was normally held by colleges at Oxford and Cambridge Universities, occurred during a later period of research expansion for the Welsh institution.[1151]

Infrastructure Developments and Departmental Ethos

Any immediate post-war plans the university college authorities were planning for departmental expansion within the science faculty were reinforced by the concerns of the newly appointed heads of the Physics, Chemistry and Metallurgy departments. By the same token their war-time research experiences of working on collaborative programmes in government laboratories encouraged the realisation that departmental expansion at the Swansea institution was critical, especially if the individual science departments were to plan and engage with the growing specialisation of science disciplines. As the University Senate consisted of the heads of the academic departments it was aware of the inadequacies of the individual constituent colleges.[1152] In 1944 the University Senate compiled a report on the University College of Swansea which addressed the post-war needs and future policies of the college.[1153]

Sections of that report related to the science departments and noted that the historical problems of limited department and laboratory space and inadequate numbers of teaching staff were still issues for successful departmental development. While there was a recognition that Professor Mockeridge's pre-war plans for a permanent building to house the Biology and Geology had to be constructed, there was no reference for

[1149] Interview with John H. Beynon' [transcript], by Michael A. Grayson, April 2008, *Chemical Heritage Foundation* Science History Institute, Centre for Oral History, 0420, Born 1923, Online: https://oh.sciencehistory.org/oral/-histories/beynon-John-h. [accessed 15 October 2018], p. 43.
[1150] Grayson, pp. 43-4. Beynon was also the Founder chairman of the British Mass Spectrometry Society (1960), founding member of the American Society for Mass Spectrometry (1967), Founder President of the European Spectrometry Society (1993). See 'Getting Ions Up to Speed: Understanding Mass Spectrometry' https://sciencehowstuffworks.com>...>Chemistry [accessed 15 October 2018].
[1151] Dykes, p. 215.
[1152] Williams, p. 6.
[1153] University College of Swansea, *Report of the Senate on Post-War Needs and Policy, adopted by the Council of the College* (Oxford: The University Press, 1944).

plans to erect permanent buildings to house chemistry, physics, and metallurgy. It is apparent that the Senate viewed the construction of a permanent building to be critical if the disciplines of zoology and geography were to be successful at the Swansea University College.[1154] However, the absence of written evidence of discussions or plans to replace the temporary science blocks during the immediate post-war period suggests that the university authorities were content to continue to use the temporary buildings. This was in sharp contrast to Swansea's sister college at Cardiff, where the construction of the Viriamu Jones Memorial Research block began in 1948 and during the following two years the construction of the block for physics and chemistry (Tatem Wing) was completed.[1155] Furthermore, by the end of the 1940s the University of Wales' two other constituent colleges at Aberystwyth and Bangor had started construction on new chemistry buildings.[1156]

The priority for building expansion for the University College of Swansea authorities during the immediate post-war period was a Faculty of Arts.[1157] Yet, there were clearly serious problems with the aging science block, and the situation in the physics block was described in detail in Llewellyn-Jones's 1946 report.[1158] The report was a damming indictment of the persistent practical deficiencies of the department and gave a clear appraisal of what was needed to modernise the department. As he had worked in the Physics department for 13 years before being appointed as head of department, Llewellyn-Jones had practical experience of teaching and researching in increasingly inadequate facilities.[1159] According to his colleagues Llewellyn-Jones was considered to be courteous and charming in his private life, however in his professional role Llewellyn-Jones was outspoken with an independent attitude towards the influences and views of the established authorities. Llewellyn-Jones's outspoken comments in his report reflected these traits.[1160] The report was frank about the problems of teaching in an aging 'temporary' building with its damp, and inadequate heating, electric, gas and water supplies.[1161] The dangerous practice of storing industrial

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[1154] UCS, *Report of the Senate on Post-War Needs and Policy*, pp. 11, 19, 23.
[1155] Morgan, p. 49. The Tatum Wing referred to the family name of the local shipowner and college benefactor, Lord Glanely.
[1156] Morgan, p. 50.
[1157] UCS, *Report of the Senate on Post-War Needs*, p. 12.
[1158] RBA, reference no: UNI / AS / SU / 2 / 1 / 358, Frank Llewellyn Jones, *Report on the Immediate and Post-War needs of the Physics Department* (1946).
[1159] Dutton.
[1160] Dutton.
[1161] RBA / UNI / US / AS / 2 / 1 / 358, pp. 2-3.

batteries inside the main building is as Llewellyn-Jones expressed, 'to be deplored', due to the corrosive effect their toxic fumes have on contact with metals. Such conditions required a re-organisation and update of all the laboratory space, as well as the purchase of further specific expensive apparatus and equipment for teaching and research purposes.[1162]

Llewellyn-Jones's plea for the teaching and research space in the department to be immediately upgraded to deal with the increasing complexity of delivering modern physics modules was realised. A capital grant from the UGC of £13,500 paid for a range of internal alterations and additions, although as David Dykes points out in his history of the institution the building update did not translate into a policy of permanence.[1163] This was the opposite to the conversations of permanence that had surrounded the new library building which was completed in 1937.[1164] The limitations to post-war departmental expansion experienced by the Physics department were not shared by the departments of Biology and Geology. Both departments had experienced the problems of limited teaching and research space and staff numbers compounded by increasing student numbers that the other science departments had suffered. However, in 1953 plans for Florence Mockeridge's long-term vision of a permanent block in which to accommodate the natural sciences were being drawn up.[1165] The design of the building was undertaken by the firm Sir Percy Thomas and Son who would be responsible for other buildings on the Swansea campus, however, the natural sciences building was designed by Sir Percy himself.[1166]

The project was viable due to the Corporation of Swansea's grant of additional land and a grant from the UGC.[1167] In their discussions with the Corporation requesting additional land the college authorities used the institution's part in the post-war reconstruction of Swansea as a reason to grant their request, stating that; 'It (the college) needs an enlargement of its living room to house buildings worthy both of its status as a university and of the new Swansea of which it will form an essential part!'[1168] As with other towns and cities in Britain the central areas of Swansea had suffered serious bomb

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[1162] RBA/ UNI / SU / AS / 2 / 1 / 358, p. 2.
[1163] Dykes, p. 147.
[1164] Dykes, p. 147.
[1165] RBA, reference no: UNI / SU / AS / 2 / 1 / 518, *Progress Report* (24 July 1954).
[1166] Morgan, p. 52.
[1167] H. E. Street, 'University College of Swansea, New Science Laboratories' in *Nature* vol. 179 (1957), 124-26 (p. 124).
[1168] RBA, reference no: UNI / SU / AS / 2 / 1 / 539, *Notes in support of the Application by the University College of Swansea to the Corporation of Swansea for a grant of additional land* (1955), p. 1.

damage, and there were post-war plans to reconstruct a Declaratory Area of 290 acres.[1169] Part of that reconstruction were the clearance of the older parts of the central areas of Swansea, as well as restarting the slum clearance programmes, which had been stopped during the war years.[1170] As with other parts of Wales construction was at the heart of modernising post-war Swansea, with new homes, public buildings and the extension of its educational facilities being planned.[1171] Therefore, the creation of new buildings at the Singleton campus were crucial to the modernising process of the region. The acreage being used for the university college at Swansea was significantly smaller than other higher educational institutions, and this gave the college authorities leverage when requesting more space to extend the Swansea campus.[1172]

In 1955 there were just over 1,000 students at Swansea University College contained on a campus site of 34 acres and the college authorities were requesting another 32 acres. The donation of land enabled the construction of a completely new layout for the College and signified a crucial move by the university authorities towards accommodating scientific departmental expansion.[1173] This was still a limited size compared to Swansea's sister college at Aberystwyth which had access to 400 acres for 1,200 students while Exeter University had use of 220 acres for 940 students.[1174] The availability of adequate space for faculty expansion varied from institution to institution as the table below illustrates.

1169 D. T. Herbert, 'The Twentieth Century' in *Swansea and its Region* ed. by W. G. V. Balchin (Swansea: University College of Swansea, 1971), pp. 186-87.
1170 Herbert, pp. 186-87.
1171 Brian Howells, 'Modern History' in *Wales A New Study* ed. by David Thomas (London: David & Charles, 1977), pp. 116-17.
1172 RBA, UNI / SU / AS / 2 / 1 / 539, *Application for a grant of additional land*, p. 1.
1173 Street, pp. 124-26.
1174 RBA, UNI / SU / AS / 2 / 1 / 539, *Application for a grant of additional land*, p. 5.

Figure 11: New and Projected Botany Departments

University or College	Total Undergraduate Population (Commonwealth Universities YearBook 1955).	Botany Department				
		Date	No. of Rooms	Working space sq. ft.		
				Total	Physiology teaching	Post-graduate student research [b]
Swansea	894	by 1956	17 + 4 [a]	8000	Nil	600
		when wings completed		14,000	approx 4,500	
Bangor	861	1955		19,250	3,600	2,600
					6,200	
Cardiff	1,533	to be completed 1959	78	30,510	8,500	
Aberystwyth	1,071	Projected. Detailed plans prepared.	50	16,752 (exclusive of large joint lecture theatre)	4,181	1,140
					5,321	
Nottingham	2,037	1954		26,866 (exclusive of lecture rooms)	2,758	3,950
					6,738	
Oxford	6,878	1951	79	32,400	ca 10,470	

[a] Jointly with Zoology [b] exclusive of research facilities in private staff rooms

Reference no: Richard Burton Archives, UNI / SU / AS / 1 / 1 / 34

The table gives a detailed analysis of the space made available during 1955 for new and projected Botany departments in comparison to the numbers of students. In this instance the space made available for the Botany department in the new science building at Swansea fares well in its ratio of departmental space available to students.[1175]

[1175] RBA, UNI / SU / AS / 1 / 1 / 34, *New and Projected Botany Departments*.

The construction of the new natural science building was a significant development for the future expansion of scientific teaching and research at the University College of Swansea. While the building was designed to accommodate the four departments of Biology, Zoology, Geology and Geography, the addition of inter-disciplinary facilities of a joint lecture theatre and library facilities were also incorporated into the plans. Each departmental space provided separate teaching and research facilities with enough laboratory capacity to accommodate the diversification of the separate science disciplines. In the Department of Geology there were also laboratories for palaeontology and stratigraphy, petrology and mineralogy, geochemistry and a general laboratory.[1176] The attention to detail in the fittings and furnishings of the science building were mainly due to Professor Mockeridge and professor of Geology Duncan Leitch who were very involved in the planning and worked in close co-operation with the architect, Sir Percy Thomas.[1177]

In 1954 Mockeridge retired and the newly appointed professor of Botany H. E. Street became involved in planning discussions.[1178] The overlap between Mockeridge's retirement and Street's arrival from Manchester to take up his position as her successor caused issues for Street. A series of letters were exchanged between Street, Mockeridge and the college registrar regarding the appointment of a Research Demonstrator, as Street had expressed a desire to be involved in the interviewing process considering the appointment key to building a research school. However, the candidates were interviewed only by Mockeridge, leading a frustrated Street to state that the college's level of consultation with him was 'farcical'. Also, the issue of departmental authority was raised between the two professors. Mockeridge wished to continue to be involved with the present research students and her appointment as Emeritus Professor by the University of Wales defined her participation.[1179] While Street wished to accommodate Mockeridge he made his reservations known to the registrar, writing that: 'I hope, however, that it will not be expected that I accept automatically a position where the retiring Professor retains final responsibility for members of the Department'.[1180]

[1176] Street, pp. 124-26.
[1177] Street.
[1178] RBA, reference no: UNI / SU / AS / 2 / 1 / 521, Professor H. E. Street, *Letters to Registrar* (13 April and 16 June 1954).
[1179] RBA, reference no: UNI / SU / AS / 2 / 1 / 561, University College of Swansea, *Emeritus Professor Mockeridge.*
[1180] RBA / UNI / SU / AS / 2 / 1 / 521, *Letters to the Registrar.*

Mockeridge had created and developed the Biology department and the new natural science building was her legacy, therefore relinquishing her involvement in the later planning stage to her successor must have been difficult. Especially as Street had compiled his own detailed alterations to the internal plan of the new building.[1181] The conversations between Mockeridge and Street reveal how an academic department was still acknowledged to be personal domain of the head of department during the 1950s. Furthermore, the ethos of the academic community within that department was determined by its head. This was contrary to the American system in which a head of department was an administrator leading a large department, and encompassing the research and influence of numerous professors.[1182] However, the British system remained a strictly linear hierarchy.[1183] An organogram depicting the departmental staff structure at the Swansea institution is illustrated in Appendix C. By its very nature this hierarchical system supported and encouraged class divisions, as illustrated by a certain concern of Fulton.[1184] Fulton disapproved of professors and lecturers of the institution appearing together on radio broadcasts, as he considered that their relationships should resemble that of the military code between officers and men.[1185]

The hierarchical aspect of the British academic system enabled the heads of the science departments to influence the direction of research within their departments.[1186] Yet, did the status and power of a hierarchical system impede the development of a department's distinct quality? Assessing a departmental head's influence on the character of the departmental community is a difficult task, however, the use of oral history interviews with departmental staff members is one way of assessing the head of department's impact. With regard the science faculty's departmental heads at the University College of Swansea the oral histories of Diane Lomax and Betty Griffiths give an insight into the headships of Professor Mockeridge and her successor, Professor Street. Diane Lomax was a secretary to Mockeridge during the early 1950s and noted

1181 RBA / UNI / SU / AS / 2 / 1 / 521, *Letters to the Registrar*.
1182 Joseph Ben-David, *The Scientist's Role in Society A Comparative Study* (Chicago and London: The University of Chicago Press, 1984), pp. 154-55.
1183 Ben-David, pp. 154-55.
1184 Martin Johnes, *Wales since 1939* (Manchester: Manchester University Press, 2012), p. 136.
1185 Johnes, p. 136.
1186 Ben-David, p. 154.

that the Professor was a consummate professional with staff members and ruled the department with a 'rod of iron'.[1187]

In addition, the professional hierarchical character of the department was enforced by staff always being referred to by their surnames.[1188] On the other hand Betty Griffith's memories of working in the department as a junior laboratory assistant with Professor Street reveal a change within the Botany Department.[1189] While the hierarchical system was maintained as illustrated by staff being ordered to attend departmental events such as the annual lecture and dinner, Street introduced a more relaxed working environment. Betty Griffiths remembered that Street referred to her as 'Betty' while she called him 'Prof' and noted the departmental customs that he initiated. These included new members of staff being obliged to sit at the top table at the annual dinners, and the giving of a dated tankard by Street to postgraduate students at their graduation party. This last custom which developed into the Tankard Club defined the character of Street's department. At his retirement Street took the unusual step of organising a special dinner for the Tankard Club, and the attendance of nearly 60 past research students was a measure of the high regard to which he was held.[1190]

The lecturing style of a senior member of staff could also add to the distinctive qualities of a department. This was very much the case in the Physics department at the University College of Swansea during the immediate post-war period with the arrival of Granville Beynon and Frank Llewellyn-Jones. Beynon's contribution to academic teaching and research began when he returned to the University College of Swansea in 1946, after his period of wartime research at the Radio Division of the National Physical Laboratory.[1191] Beynon accepted the post as Lecturer in the Physics Department at the same time as Frank Llewellyn-Jones took on the post as head of the department.[1192] Both scientists are remembered for their unusual but highly effective teaching

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[1187] Interview with John and Diane Lomax by Sam Blaxland, March 2017, *Voices of Swansea*: *1920-2020,* Richard Burton Archives, reference C0001/10, track 1, © Swansea University [accessed 14 November 2018].
[1188] Lomax.
[1189] Interview with Elisabeth 'Betty' Griffiths by Sam Blaxland, July 2017, *Voices of Swansea*: *1920-2020,* Richard Burton Archives, reference C0001/26, track I, © Swansea University [accessed 14 November 2018].
[1190] Griffiths.
[1191] Mary Auronwy, James, 'Beynon, Sir William John Granville (1914-1996), Professor of Physics' *Dictionary of Welsh Biography* (2012), http://yba.llgc.org.uk [accessed 11 September 2018].
[1192] Neville Evans, 'Scientist of Wales: Ieuan Maddock, F.R.S.,' in *Cymru Culture* (2014), http://www.cymruculture.co.uk/featuredarticles91017.html [accessed 21 October 2016].

methods.[1193] Beynon communicated complex theories with flair and enthusiasm which were well received and inspiring to his students, and his lectures were even considered a ‘work of art’ by one colleague, John Meurig Thomas.[1194] Likewise, the lecturing technique of Llewellyn-Jones did not follow the traditional didactic method, but was an enlightening discourse on abstract topics which both educated and ‘enthralled’ his students.[1195] In fact, the impressive teaching style of Llewellyn-Jones is an example of the primary role expected of the professoriate, a function which was gradually overtaken during the 1950s by the bureaucracy and affairs of expanding departments.[1196]

Expansion of National and Transnational Collaborative Research Projects

The increase in staff numbers and the development of the facilities of the science faculty gave an impetus to the size of the research projects undertaken by the science departments. In the College’s 1944 report there was an acknowledgement of the increasing diversity of the research projects undertaken within the physical and applied science departments.[1197] Furthermore, there was a move to upgrade the college’s status in scientific research by recommending that the category of Reader should be established in the science faculty with appointments being made in Quantum Mechanics, X-ray Crystallography and either Aeronautics or Meteorology. The concept of the position of Reader was not intended as an individual departmental development, but the creation of a research facility which crossed departmental boundaries and would be closely connected to the Reader’s area of specialised research.[1198] While there were increasing appointments of Readers at universities there were inconsistencies in the conditions to the appointment by individual institutions.[1199] This became apparent during discussions at the 1955 university registrars conference, although it was agreed that the appointment was a senior post offered to an academic who was outstanding in their particular academic field. What is clear is that those universities such as

[1193] Evans. John Meurig Thomas, ‘Obituary: Professor Sir Granville Beynon’ *Independent News* (1996), https://www.independent.co.uk>News>Obituaries [accessed 17 October 2018].
[1194] Thomas.
[1195] Evans.
[1196] Moodie and Eustace, pp. 213-14.
[1197] University College of Swansea, pp. 24-25.
[1198] University of Swansea, pp. 34-36.
[1199] RBA, reference no: UNI / SU / AS / 2 / 1 / 534, Registrars’ Conference, *Minutes of Conference of Registrars held in the Senate Room in the University of Glasgow* (6 April 1955), p. 2.

Manchester and Birmingham who historically had established the post, had defined the conditions and grade of the appointment. [1200]

The future appointment of Readers was a policy which Llewellyn-Jones argued for in his 1946 departmental report on the 'Immediate and Post-War needs' of the Physics department, which he compiled after being appointed as head of the Physics department.[1201] In relation to the Physics department the appointment of a specialised Theoretical Physicist either as a Reader or assistant Professor was considered necessary.[1202] As evidence to support his plans for a departmental Reader Llewellyn-Jones researched the situation at other university Physics departments. By the end of the decade Llewellyn-Jones had compiled data of the number and distribution of Physics staff in the comparable English universities of Sheffield, Nottingham, Exeter and King's College.[1203] Also included in the analysis were the Swansea institution's sister colleges of Aberystwyth, Bangor and Cardiff. The results revealed that Swansea had fewer staff in the highest ranks of Professors and Readers (although not in relation to total number of staff), as well as a poorer staff – student ratio.[1204] The 'action plans' of Llewellyn-Jones reflected a serious move to have the facilities of his department updated and extended. Llewellyn-Jones also suggested that there needed to be an addition to the hierarchal structure of the Faculty of Science. Llewellyn-Jones argued that due to increasing numbers of students and the range of scientific research undertaken, the faculty needed to create a sub-faculty with the post of sub-dean who would solely deal with the applied science students.[1205]

Regardless of Llewellyn-Jones departmental infrastructure plans which did not materialise during this period, one departmental addition cemented an area of research within the Physics department. This was the creation of a Radio-Physics Research Station within the university college grounds, which had been built with the co-operation of Professor Emrys Williams of the Electrical Engineering department at Bangor College.[1206] A small group of students organised and led by Dr John Beynon

[1200] RBA / UNI / SU / AS / 2 / 1 / 534, p. 2.
[1201] RBA, reference no: UNI / SU / AS / 2 / 1 / 358, Frank Llewellyn-Jones, *Report on the Immediate and Post-War needs of the Department of Physics* (1946), p. 6.
[1202] RBA/ UNI / SU / AS / 2 / 1 / 358, *Post-war Report*, p. 6.
[1203] RBA, reference no: UNI / SU / AS /2 / 1 / 407, Frank l Llewellyn-Jones, *Department of Physics Staffing needs for the remainder of the quinquennium 1949-1952*, p.1.
[1204] RBA/ UNI / SU / AS / 2 / 1 / 407, *Staffing needs*, p. 1.
[1205] RBA, reference no: UNI / SU / AS / 2 / 1 / 382, Frank Llewellyn-Jones, *Report on the need for a Sub-Faculty of Applied Science*
[1206] RBA, *Report of the Council* (1950-51), p. 63.

and Dr Godfrey Martin Brown had set up a research study of the ionosphere using a method established in 1941, which enabled researchers to make observations with pulsed radio signals.[1207] However, the field station which was situated at Hendrefoilan, Swansea, was abandoned by the department in 1949 when the Air Ministry derequisitioned the site, and Llewellyn-Jones was reluctant to renegotiate with the owner of the land.[1208] The unwillingness to continue with the Hendrefoilan site was due to its isolated location which made the station vulnerable to vandalism and theft, and the extensive damage and theft of valuable radio equipment during the summer vacation of 1949 halted John Beynon and his student's research.[1209] The research that continued at the new station the following year was reviewed and appreciated by Reginald Leslie Smith Rose (1894-1980), Director of DSIR Radio Research Establishment.[1210] The success of the project influence Professor William's decision to bring into operation a second ionospheric sounding station, which was sited at the University College of Bangor.[1211]

Smith Rose's appearance at the institution was due to an arranged official visit to the Physics department to discuss the department's research projects, and he was accompanied by other scientists such as Professor W. Lewis Hyde, United States attaché of the Office of Naval Research (ONR).[1212] Established in 1946 the post-war remit of the ONR was to strengthen and maintain the successful scientific collaborations between government, academia and industry, as well as to encourage scientific and technological innovations.[1213] Yet, its only overseas branch office in London which grew out of the federal government agency, the Office of Scientific Research and Development (OSRD) did little contract related work with universities, and its main remit was to act as 'a window on European science'.[1214] This not only entailed gathering information on the latest research developments, but also supported visiting

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[1207] James.
[1208] RBA, reference no: UNI / SU / AS / 2 / 1 / 410, Frank Llewellyn-Jones, *Letter to the Principal* (20 September 1949).
[1209] RBA/ UNI / SU / AS / 2 / 1 / 410.
[1210] UCS, *Thirty-First Report of the Council* (1950-51), p. 62. Reginald Leslie Rose-Smith, physicist' in *Grace's Guide to British Industrial History* https://www.gracesguide.co.uk [accessed 28 November 2018].
[1211] UCS, *Thirty-First Report of the Council*, p. 63.
[1212] UCS, *Thirty-First Report of the Council*, p. 62.
[1213] Colin E. Babb, *The Historical Records of the Office of Naval Research*, https://www.onr.navy.mil/-/media/Files [accessed 28 November 2018].
[1214] Harvey M. Sapolsky, *Science and the Navy: The History of the Office of Naval Research* (1990), https://www.jstor.org/stable/j.ctt7zvnabn [accessed 14 may 2019], p. 49.

American scientists in establishing contact with their counterparts in a war torn Europe.[1215]

Encouraging scientific cooperation was a key part of Beynon's career.[1216] His nationally and internationally acclaimed reputation, which was established through his research on the ionosphere and radio propagation, allowed him to play a leading role in international co-operative projects. While working at the University College of Swansea Beynon was part of a seminal development in international cooperation in geophysics, the International Geophysical Year (IGY) of 1957-58. The efforts of this year long event were summed up in a National Academy of Sciences IGY Programme report, '…to observe geophysical phenomena and to secure data from all parts of the world; to conduct this effort on a coordinated basis by fields, and in space and time, so that results could be collated in a meaningful manner'.[1217] The year-long event was based on similar early projects, the International Polar Years of 1882-1883 and 1932-1933. The IGY project of 1957-1958 would involve participants from 67 countries.[1218] Later in his career Beynon was a key figure in the establishment of other international scientific co-operation projects notably in the radar project, EISCAT in Scandinavia.[1219] The world's most advanced ionospheric radar was originally intended to be used by scientists from France, Germany and the three Nordic countries, but the inclusion of British scientists was down to the efforts of Beynon.[1220]

Beynon's involvement in a key development of a specialized area of international physics epitomised a general development in scientific research during the mid-1950s; the steady growth of key developments in specific areas of scientific disciplines.[1221] A repercussion of the increase in research projects was a copious amount of specialised and narrowly focused knowledge.[1222] The research was published across a widening range of specialised scientific journal, with academic publication being a sign of a successful science department. The Table below illustrates a recorded list for an internal

[1215] Sapolsky, p. 49.
[1216] Emma Unander, *Sir William John Granville Beynon* (2016), https://www.eiscat.se/about/sir-granville-beynon [accessed 15 May 2019].
[1217] National Academy of Sciences, *The International Geophysical Year* (2005), www.nas.edu/history/Igy/ [accessed 15 May 2019].
[1218] National Academy of Sciences.
[1219] Unander.
[1220] Unander.
[1221] Sally M. Horrocks, 'The Royal Society, its Fellows and Industrial R&D in the Mid Twentieth Century' in *Notes and Records of the Royal Society of London*, vol. 64 (2010), S31-S34, https://www.jstor.org/stable/20753920 [accessed 29 April 2018], p. S39.
[1222] Horrocks, p. S39.

report of the number of articles as well as other written material produced by certain departments of the science faculty during the period 1952-1955.[1223]

Figure 12: List of Published Works by Staff of the Science Faculty, 1952-1955

Discipline	Articles	Reviews	Reports	Books	Editorial
Physics	34	8	4	0	0
Chemistry	67	0	0	1	1
Geology	8	0	0	0	0
Geography	13	3	0	1	1
Botany	27	0	0	0	0

Reference no: Richard Burton Archives, UNI / SU / AS / 2 / 1 / 559

The report does not include the numbers of published works by the disciplines of Applied Science such as metallurgy, which during the three academic years produced 40 articles and 6 reviews.[1224] The number of published articles continued to rise as the departmental reports in the institution’s calendars reveal, with 76 articles being published in the academic year of 1959-1960 by the above-listed science disciplines including Metallurgy and Zoology, with one publication by the new department of chemical engineering.[1225]

The difficulty for the individual scientist of keeping abreast with the amount of new knowledge in their field was eased by demands for the establishment of more formal ‘spaces’ to connect and interact with other scientists in academia, industry and research establishments.[1226] One such space for scientists working in a specific area of a discipline was the symposium event, which the different departments at the University College of Swansea arranged and hosted. One such meeting was hosted by the Physics department at the Swansea institution in 1951 titled a Symposium on Aspects of Discharge Physics, which was arranged by the Physical Society of Great Britain. [1227] The organisers of the event had requested that the symposium be held at the Swansea institution, and over three days (29-31 March)150 scientists from universities, government research establishments, larger electric research associations and industrial

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[1223] RBA, reference no: UNI / SU / AS / 2 / 1 / 559, *List of Published Works by University College of Swansea Members of Staff, 1952 to June 1955.*
[1224] UCS, *Thirty-Third Report of the Council* (1952-1953). *Thirty-Fourth Report of the Council* (1953-1954). *Thirty-Fifth Report of the Council* (1954-55).
[1225] UCS, *Fortieth Report of the Council* (1959-1960).
[1226] Horrocks, p. S39.
[1227] Richard Burton Archives, University College of Swansea, *Thirty-First Report of the Council 1950-51*, p. 62.

firms from across Britain listened to research papers. There was also involvement at the symposium from the British Iron and Steel Research Association (BISRA) laboratories at Sketty Hall in Singleton Park.[1228]

The origin of BISRA was an example of a successful partnership between academic and industrial research.[1229] A published report in 1955 into all aspects of the organisation and relationship of research between British universities and industry noted the practice of seconding scientists from industry to undertake research in university laboratories.[1230] The report warned of the danger of the university laboratory being used as a cheap resource for industry, and suggested that these type of research arrangements should only be used for specialised research.[1231] In connection with the report a questionnaire was sent out in 1953 to 4,578 university lecturers and heads of departments requesting information on the relations between scientific research and universities, of which there were 2, 016 replies. The table below is an analysis of the replies that related to research undertaken in universities for outside organisations in scientific disciplines that are discussed within this study.

Figure 13: Lecturers reporting work done within the University for Outside Bodies.

	Nature of Outside Body						Payments Made			
	Research Associations		Private Firms		Other Organizations		To the Lecturer		To the Department	
		%		%		%		%		%
Physics	14	7	13	7	16	8	8	4	21	11
Chemistry	17	6	27	9	26	9	26	9	45	16
Geology	1	1	14	16	14	16	17	20	3	3
Botany	6	4	8	6	19	13	7	5	9	6
Zoology	3	2	11	6	19	11	13	7	3	2
Biochemistry	0	0	0	0	3	7	0	0	3	7
Industries (Metallurgy)	15	14	42	39	27	25	26	24	45	42

NB: The percentages relate to the proportions of lecturers who replied to the question and answered yes.

[1228] UCS, *Thirty-First Report*, p. 62.
[1229] RBA, reference no: UWS, Swansea University Misc. (2 of 3), S. S. Carlisle, 'The Work of the B.I.S.R.A. Coatings Research Laboratory at Sketty Hall, Swansea' in *Metal Finishing Journal* (no.2), 159-165, p. 159.
[1230] V. E. Cosslett, ed., *The Relations between Scientific Research in the Universities and Industrial Research* (London: The International Association of University Professors and Lecturers, 1955), p. 78. The report was the result of an enquiry by the Association of University Teachers (AUT) in co-operation with the International Association of University Professors and Lecturers (IAUPL). The enquiry was set up in 1953 and published with a grant by UNESCO.
[1231] Cosslett, pp. 78, 99-120.

While the table does not relate specifically to the University College of Swansea (although the report notes that the best responses came from the smaller English universities and the colleges of the University of Wales), the results confirm that scientific researchers across the scientific disciplines in academia had established connections with a wide range of research facilities.[1232]

Sometimes internal academic research evolved into a commercial facility, as was the case with the specialized research project at Swansea's Metallurgy department that became the nucleus of the B.I.S.R.A laboratories at Sketty Hall.[1233] Since 1932 a research project into the effects of cold rolling and heat treatment on the properties of mild steel sheet had been set by the South Wales Siemens Steel Research Committee and the Welsh Plate and Sheet Manufacturers' Association using the Swansea institution's metallurgy laboratories. The research group was led by D. Luther Phillips, although it was under the direction of Edwards the head of department. [1234]

The successful growth of the project, which had been assimilated into the newly formed B.I.S.R.A. in 1945, required a larger base than what could be acquired in the university college science faculty. In 1946 the project procured the 40 roomed mansion, Sketty Hall which was situated in Singleton Park, and the move consolidated the project as the B.I.S.R.A. Coatings Research Laboratory.[1235] The mansion's close proximity to the campus ensured that close relations with the university college continued, and by 1955 physics, metallurgy and engineering graduates from the Swansea institution were being offered posts at the well-equipped laboratories.[1236] Furthermore, the Sketty laboratories maintained close links with the B.I.S.R.A. Chemistry department based at the London Battersea Laboratories, who were responsible for undertaking research into corrosion.[1237]

During the 1950s the departments of chemistry, physics and metallurgy continued with their historic connections with industry. Departmental connections with industry were expanding through the increasingly varied research projects within the university laboratories, and through collaboration with commercial and government laboratories outside of Wales. Commercial laboratories such as Glaxo Laboratories at Middlesex

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[1232] Cosslett, p. 120.
[1233] RBA, UWS / 2, Carlisle, p. 159.
[1234] Carlisle, p. 159.
[1235] RBA, UWS / 2, Carlisle, p. 159.
[1236] RBA, reference no: UNI / SU / AS / 1 / 1 / 47, S.S. Carlisle, Head of Laboratories, *Letter to Fulton* (17 May 1955).
[1237] RBA, UWS / 2, Carlisle, p. 165.

financially supported the research into cortisone by making yearly contributions towards departmental expenses.[1238] Financial support from industrial firms was often given to support specific research which was earmarked for the acquirement specific apparatus and materials or the support an Honours graduate undertaking that research.[1239] In certain cases the use of the donation was made clear by the head of department, as illustrated by the £1,000 donation from the National Oil Refineries to the Chemistry department.[1240] In this instance Professor Shoppee wished to use the money over a two to three year period to support a Research Fellowship.[1241] Another commercial collaboration that involved the Chemistry department during the second part of the 1950s was headed by Shoppee's successor, Professor Hassall (1919-2017).[1242] The American pharmaceutical company Chas. Pfizer & Co., made a £1,500 grant to support a research programme in Botanicals which would assist in obtaining and extracting plants.

While staff and students at the University College of Swansea were involved in research programmes that were in collaboration with other agencies from different parts of Britain, there were increasing opportunities and support to be part of overseas research. Often opportunities for students were in the form of travelling scholarships which had to be taken during the summer vacation.[1243] Financial support was offered by research institutions and organisations and included the Institution of Mining and Metallurgy who arranged for students to work in Canada, and the British Iron and Steel Federation who sponsored student exchanges to France which gave the British students access to the workings of a French steel works.[1244] During the 1950s members of staff from the different science departments were also increasingly involved in international collaborative research projects. One notable project was the Cambridge Austerdalsbreen Expeditions which organised research trips between 1954 to 1963 to study glacial

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[1238] RBA, reference no: UNI / SU / AS / 2 / 1 / 492, Sir H. Jephcott, Glaxo Laboratories, *Letter to Professor Shoppee* (16 July 1953).
[1239] RBA, reference no: UNI / SU / AS / 2 / 1 / 492, J. W. Barrett, Monsanto Chemicals Ltd, *Letter to Professor Shoppee* (25 June 1953).
[1240] RBA, reference no: UNI / SU / AS / 2 / 1 / 492, Professor Shoppee, *Letter to the Registrar* (17 November 1953).
[1241] RBA, UNI / SU / AS / 2 / 1 / 492.
[1242] RBA, reference no: UNI / SU / AS / 2 / 1 / 571, Chas. Pfizer & Co., Inc., Letter to Dr C. H. Hassall (11 July 1957). The Royal Society, 'Cedric Hassall' in *Fellow Directory*, https://royalsociety.org/people/cedric-hassall-11585 [accessed 22 / 01 / 2020].
[1243] UCS, *Thirty-third Report of the Council* (1952-53), p. 51.
[1244] RBA, UCS, *Thirty-third Report of the Council*, p. 51.

movement on Austerdalsbreen in Norway.[1245] Professor Balchin head of the newly established Geography department joined 16 geologists on the 1955 expedition, which included Sir Edward Bullard, Director of National Physical Laboratory, P.D. Baird, Director of Artic Institute of North America at Montreal and Professor H. V. Sverdrup, Director of Geophysics, University of Oslo. With collaborative funding from the Royal Society Everest Foundation, industry, and academia the project also offered field work to approximately 30 undergraduates during the summer break. [1246] In other departments field trips were an essential part of the curriculum, such as Geology which continued in its tradition of field trips during the recess periods, a research opportunity which had been established under the department's first head of department, Arthur E. Trueman.[1247]

Conclusion

Post-war developments at the science faculty of the University College at Swansea were defined by the juxtaposition of national austerity and post-war reconstruction, and at a time when Britain was reconnecting with European countries on scientific, commercial and industrial levels. Post-war reconstruction was facilitated partly by the financial support of the American European Programme, and the support of the USA administration for an economically united Europe and the restoration of European industry. Central to this reconstruction was science and industrial progress which was underpinned by an emerging optimism and idealism within European societies. Britain was also undergoing radical changes in social and cultural aspirations despite post-war poverty and rationing. This was partly generated by an increasing awareness of the role of science in the research and development of a new generation of commodities and services, with public opinions being formed by an emerging mass media.

National interests in scientific developments and a political awareness that the success of post-war construction depended on the expansion of higher scientific education shaped government strategy on science and education. The strategy was

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[1245] RBA, UNI / SU / AS / 2 / 1 / 542, *Cambridge Austerdalsbreen (Norway) Expedition* (1955). For a detailed report on the Austerdalsbreen expeditions during the 1950s and early 1960s see: John Nye, 'The Cambridge Austerdalsbreen Expeditions, 1954-63' in *Annals of Glaciology* vol. 24 (1997).

[1246] RBA / UNI / SU / AS / 2 / 1 / 542.

[1247] W. J. Pugh, 'Arthur Elijah Trueman, 1894-1956' in *Biographical Memoirs of Fellow of the Royal* Society, vol. 4 (1958), 291-305 http://rsbm.royalsocietypublishing.org [accessed 23 October 2017], pp. 294-95. The RBA holds reports of departmental field trips such as reference: RBA / UNI / SU / AS / 2 / 1 / 542, *Report of Field Work and Research carried out in June to August* (1955). *Report of the Research Grants Committee on work carried out during the period 1 June 1955 to 1 December 1955.*

underpinned by the Percy Report and the Barlow Report's recommendations which addressed specific issues of administrative structure, and channelled state funding to support the expansion of higher scientific and technical education. The doubling of science student numbers translated into specialised scientists and technicians that were required to meet the increasing requirements of an industrial and commercial expansion. However, the transformation of wartime military / industrial / academic collaborative research into post-war 'Big Science' programmes drew in many science graduates and attracted scientists and technologists from across the spectrum of industry and academia. The University of Wales and its constituent colleges was no exception as a large community of Welsh graduates and scientists, with some in key positions worked on the British nuclear weapons programme. However, the commitment of ever-increasing resources of skilled personnel and funding to the nuclear weapons and nuclear power project compromised the extent of post-war domestic re-construction.

Facilitating the increase in student numbers to accommodate the national demand for scientists and skilled labour ensured there was little restraint on university funding. The expanding role of the UGC and increased university funding enabled all the constituent colleges of the University of Wales to undertake building projects to modernise science departments and accommodate growing student numbers. A post-war student population whose demography was temporarily changed due to returning military personnel. Yet, the ambitions of John Fulton, the new principal of the Swansea institution, to create a modern residential campus restricted plans to address the overcrowded, sub-standard, and dated teaching and research space of the science departments. This failure led to the implementation of a policy of temporary measures to deal with issues of inadequate departmental facilities which put pressure on the expanding numbers in the departmental communities. However, the completion of the natural science building to house the biology and geology departments was an exception. The impressive and specialised facilities of the development upgraded the departments' research status by allowing for the diversification of the two subjects, as well as establishing the departments of geography and zoology at the Swansea institution.

Additionally, the various difficulties endured by the science faculty were further complicated for the biology, chemistry, and metallurgy departments by the retirement of their long-serving head of department. The departmental inclusiveness of the small departments at the University College of Swansea ensured that new leadership styles connected with the established communities and ensured the successful continuation of research projects. While senior staff successfully enhanced the academic status of their departmental disciplines through the continuous publication of research, the efforts to establish further senior post such as that of Reader for specific areas of research was limited. As the post of Reader crossed departmental boundaries the consequences of failing to establish this post was to curb specific areas of research. Yet, despite these setbacks the instigation of symposiums and staff attendance at national and international conferences widened the institution's network of academic connections. Consequently, there was an increase in the number of national and international collaborative research programmes involving students and staff across the disciplines during the 1950s.

Chapter Six – 'Minarets to Scientific Progress';[1248] Modernization and Expansion, 1960-1970

Introduction

The 1960s was a crucial period for university development, and four decades after its establishment the science faculty at the University College of Swansea entered a period of rapid expansion. The final chapter of this study discusses the modernization of the science faculty and notes how these developments occurred during an episode of serious discord within the University of Wales. The matter of the continuation of the federal system preoccupied the hierarchy of the institution's colleges, and this section asserts that the role of the new principal of the University College of Swansea, Professor John Horace Parry was central to determining the fate of the federal system during this period. Furthermore, the chapter argues that concerns connected to university expansion was a key issue that consolidated historical grievances within the Welsh university and cultivated a challenge to its federal system. In addition, this section explores how the expansion of the institution of the university was closely inter-linked with the political ambitions of successive British governments and social and political concerns regarding a national decline.

As discussed in the previous chapters, academic and industrial collaboration were linked to economic growth and meeting the country's needs, and this connection ensured that state financial aid was channelled towards university expansion in the 1960s. Despite internal tensions this chapter attests that the University College of Swansea was successful in delivering an ambitious building programme that modernised the campus. Moreover, the research capabilities of its science faculty institution were extended to a size that was critical to the successful function of a modern university. This assertion is supported by assessing the multi-layered developments of the science faculty at the Swansea institution. In addition to departmental expansion, the chapter argues that the structure of the science degree in Wales was fundamental to the development of inter-disciplinary connections and the growth and development of sub-disciplines at the Swansea institution. Furthermore, the

[1248] Morgan, p. 108.

section discusses the impact of increasing student numbers and how the change in the demographics of the student population re-enforced the need for college expansion.

The modernization of the science faculty facilities enabled the scientific communities from the different disciplines at the institution to expand their international research connections, a development which is explored in the chapter by highlighting links with overseas academic institutions and scientific research projects. In addition to the international teaching and research connections the chapter asserts that local connections between the Swansea institution and local industry were increased, and the institution's tradition in establishing research that addressed the needs of local industry continued. Furthermore, the final section argues that the science faculty's connections with other agencies were firmly established to warrant their involvement with collaborative projects which radically improved the environment of Swansea and the wider region.

Federal Concerns and Political Will

The first academic session of the 1960s witnessed the appointment of a new principal of the University College of Swansea. Fulton had resigned in 1959 when he accepted the positions of vice-chancellor and principal of the new University of Sussex at Brighton.[1249] There followed a period of uncertainty as the supreme governing body of the Swansea institution, the Council, took a year to choose a suitable new principal, a situation which dictated the appointment of an acting-principal.[1250] The council took an unusual step and decided on Professor Llewellyn-Jones, head of the Physics department, as acting -principal, an appointment that by-passed the existing vice-principal E. Victor Morgan, Professor of Economics.[1251] The reasons for Lewellyn-Jones' appointment are unclear, however, it is apparent that the Council held him in high regard as they appointed him as principal five years later in 1965.[1252] However, in 1960 the Council appointed a new principal, John Horace Parry (1914-1982), who was a distinguished historian of maritime history and of Latin American studies.[1253] Parry's previous

[1249] Dykes, p. 179.
[1250] Jack Dutton, 'Obituary: Professor Frank Llewellyn-Jones' in *The Independent Daily Edition* (27 March, 1997), https://www.independent.co.uk/obituary-professor-frank-llewellyn-jones-5574848 [accessed 04 April 2019].
[1251] Dykes, pp. 179-80.
[1252] Dutton.
[1253] C. R. Boxer, 'J. H. Parry (1914-82)' in *Hispanic American Historical Review* vol. 63, no.1 (1983), pp. 153-155 (p. 153).

administrative post was as the Principal at the University College of Ibadan, Nigeria, and he also held the Chair of History at another colonial university, the University College of the West Indies in Jamaica.[1254] Significantly, Parry was an exceptional university administrator in the manner of the institution's first principal, Thomas Franklin Sibly, which according to the university college's historian, Dykes, was due to Parry's ability to 'compartmentalize' his mind.[1255]

While Parry's administrative qualities were a bonus for the university college during the sixties decade of expansion and development, they would prove essential in his role as the vice-chancellor of the University of Wales.[1256] Within the federal system of the University of Wales the high office of vice-chancellor was a two-year appointment that was rotated between the principal of each constituent college.[1257] The period of Parry's vice-chancellorship between 1963 and 1965 coincided with the University Commission and the federation crisis at the University of Wales.[1258] The rapid increase of English staff and students during the late 1950s and 1960s provoked a resurgence of the struggle for the ethos of the university between the traditional forces of Welsh nationalism and nonconformity, and the modernizing influence of secular pragmatism.[1259] Consequently, against a national (in this context British) background of university expansion of existing universities and planning for seven new universities, the university of Wales was in crisis over the question of federalism.[1260] Since its establishment the desirability of the federal system of the University of Wales had been questioned by educationalists, and during periods of crisis for the institution the federalism debate generated acute tensions.[1261] Financial pressures at the beginning of the twentieth century prompted moves for independency by the constituent college at Cardiff, a crisis which were only resolved by the establishment of a Royal Commission chaired by R. B. Haldane.

[1254] Boxer, p. 153.
[1255] Dykes, p. 180.
[1256] Dykes, p. 180.
[1257] D. Gerwyn Lewis, *The University and the Colleges of Education in Wales 1925-78* (Cardiff: University of Wales Press, 1980), p. 99.
[1258] Dykes, p. 180.
[1259] Morgan, p. 86.
[1260] Morgan, p. 85. The universities in process of formation included: Canterbury, Colchester, Coventry, Lancaster, Norwich, York and Brighton which was given its charter in 1961. Education in England *The Robbins Report* (London: HMSO, 1963), p. 25. www.educationengland.org.uk/documents/robbins/robbins1963.html [accessed 08 March 2019].
[1261] R. H. Williams, *Our University at the Turn of the Century* (Llanrwst: Eisteddfod Court, 1996), p. 2-6.

Subsequently, the 1918 Haldane Report effectively defined and supported the institution's federalism for the coming decades.[1262]

In his history of the University of Wales Prys Morgan asserts that the causes of the federalism crisis which emerged at the end of the 1950s were closely linked to the expansion of the constituent colleges.[1263] This argument was supported by W. M. Jones, a Reader in Physics at the University College of Wales, who claimed that further expansion of the four constituent colleges during the 1960s encouraged attitudes of autonomy within the individual colleges.[1264] The colleges' sense of independence undermined the jurisdiction of the University Academic Board over the four constituent institutions, including the decision-making process on the distribution of funding from the UGC. Furthermore, Jones noted that those academics who supported the federal system were often against the duplication of subjects within the university. Two cases illustrated the university's stance towards the proliferation of science subjects. First the institution's opposition to the establishment of a department of Biochemistry at the University College of Aberystwyth due to the existence of a successful department of Biochemistry at Cardiff, the second, the creation of a department of Geography at the University College of Swansea as there existed the highly regarded Geography department at the Aberystwyth institution.[1265] Such departmental setbacks as well as the continued growth of the University of Wales through its constituent colleges encouraged inter-college rivalries, which combined with questions of Welsh identity and regional politics fuelled the crisis.[1266]

In 1961 a joint committee set up by the University Court established itself as the University Commission, and the debate on the future path of the University of Wales and its constituent colleges became official.[1267] The commission was appointed to specifically review 'the functions, powers and administrative structure of the University and its constituent Colleges and the Welsh National School of Medicine', and assess the institution's future status.[1268] Following the establishment of the commission there were four years of meetings with complex and sometimes bitter debates and contradictory

[1262] Williams, p. 6.
[1263] Morgan, p. 85.
[1264] Richard Burton Archives, Box no. 2014 / 20 / 5 (uncatalogued), W. M. Jones, '*One Hundred Years of Physics' at U.C.W. Aberystwyth* (*2nd* draft), p. 203.
[1265] Jones, pp. 203-4.
[1266] Morgan, p. 85.
[1267] Morgan, p. 89.
[1268] Geraint H., Jenkins, *The University of Wales, An Illustrated History* (Cardiff: University of Wales Press, 1993), p. 174.

reports, which are detailed in Morgan's history of the university.[1269] However, while the final conclusion of the commission's findings favoured an independent future for the constituent colleges, the lay University Court rejected the findings and the federal system was saved.[1270] In spite of the federalists' success there were concerns for the federation's future as T. I. Ellis succinctly noted, 'the federalists won the war and lost the peace'.[1271] However, important concessions towards the independence of the four colleges were implemented, notably the colleges were awarded grants directly from the UGC and were given autonomous powers to decide which courses they offered. [1272] While the constituent colleges could now control the structure of certain degree courses, the University of Wales continued to retain its role as a degree awarding body.[1273]

Tensions over the future of the federal system did not encumber the departmental and building developments that were in process in all the constituent colleges. The two post-war decades witnessed a period of prolonged expansion of the constituent colleges of the University of Wales, with the University College of Swansea experiencing its first significant growth.[1274] This was considered a critical development, as the head of Chemistry, Professor, C. H. Hassall (1919-2017) stated that immediate large-scale developments were necessary for the 'academic health' of the college. While the senate of the Swansea institution agreed with this view, there were concerns that such growth would reduce the community ethos of the small institution.[1275] Earlier post-war growth had already increased the size of departments, and the historic concentrated campus had a far wider geographical spread.[1276] However, efforts by senior staff to engage and develop a sense of community within their new modern facilities is epitomised by the comments of the head of Geology, D. V. Ager (1924-1993), in his inaugural lecture.[1277] Ager stated that the Geology department at Swansea worked closely as a team with the

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[1269] Morgan, pp. 89-100. For further reading on the problems of the federal system of the University of Wales see: University Library Pamphlets, reference no: W/ LF 1145, R. H. Williams, *Our University at the Turn of the Century* (Cardiff: Eisteddfod Court, 1996).
[1270] Graeme C. Moodie and Rowland Eustace, *Power and Authority in British Universities* (London: George Allen & Unwin Ltd., 1974), p. 49.
[1271] T. I. Ellis, *The Guild of Graduates, 1894-1969* (Guild of Graduates, n.d.), p. 14.
[1272] Jones, p. 204.
[1273] Jones, p. 204.
[1274] Kenneth O. Morgan, *Rebirth of a Nation: Wales 1880-1980* (New York: Oxford University Press, 1981), p. 357.
[1275] Dykes, p. 172.
[1276] Dykes, p. 172.
[1277] Swansea University Library Pamphlets, Box no: LF1217, Inaugural Lectures 1947-1968, reference no: LF 1217.5.15, Professor D. V., Ager, *Geology as an Environmental Science* (Swansea: Swansea University Press, 1969), p. 23.

views of technicians, administrative staff and students being heard as well as senior staff. His conclusion that, 'It is difficult to be stuffy when one shares tents and stale sandwiches in the pouring rain on icy mountain tops!' alludes albeit in a humorous way, that the departmental community would continue.[1278]

While the expansion in the Welsh institution was connected to national concerns regarding economic growth, the post-war expansion of the constituent colleges in regard to student numbers was substantially smaller than other colleges in Britain.[1279] The table below which was created for the Robbins Report is an overall view of student numbers in universities across England and Wales, although it does not breakdown the numbers of the individual colleges.[1280]

Figure 14: Universities: by number of full-time students, Great Britain, Autumn 1962

Number of Students	Number of Universities	Universities		
23,000	1	London		
9,000	2	Cambridge	Oxford	
8,000	2	Manchester	Wales	
5,000 - 6,000	3	Edinburgh	Glasgow	Leeds
4,000 - 5,000	3	Birmingham	Liverpool	Newcastle
3,000 - 4,000	2	Bristol	Sheffield	
2,000 - 3,000	3	Aberdeen	Nottingham	St. Andrews
1,000 - 2,000	7	Durham Leicester R.C.S.T., Glasgow	Exeter Reading	Hull Southampton
Under 1,000	2	Keele	Brighton	
In process of formation	6	Canterbury Lancaster	Colchester Norwich	Coventry York

While the table places the University of Wales in one of the higher groupings of student numbers, the total of 8,000 students extends across four constituent colleges and a medical school. However, the University College of Swansea's annual *Report of the Council* for 1962 states that the number of fulltime and part-time students at the

1278 Ager, p. 23.
1279 Deian Hopkin, *The Role of Universities in the Modern Economy* (Cardiff: Welsh Academic Press, 2002), p. 33.
1280 Committee on Higher Education, *Higher Education Report of the Committee appointed by the Prime Minister under the Chairmanship of Lord Robbins 1961-63* (London: HMSO, 1963).

University College of Swansea totalled 1,654, a summation which places the college in the second lowest level depicted in the table.[1281]

Questions on the adequacy of the size of higher educational institutions and their expansion were underpinned by a political will to support and extend scientific research that gained momentum in post-war war Britain, and which continued into the 1960s.[1282] While both major political parties encouraged the expansion of science there was a change of emphasis on the direction of research being undertaken. The prominence given to the 'big science' atomic weapons and energy projects that were backed by a Conservative administration during the 1950s changed with the Labour government of 1964, who directed their support of science towards industry.[1283] A lagging economy which had given rise to a sense of national decline was a major factor that influenced this adjustment.[1284] The research of Guy Ortolano notes how pervasive the cultural phenomenon of 'declinism' had become during the late 1950s and early 1960s and identifies its place in the cultural and political spheres of British society during that period.[1285] This outlook is foremost in some of the political writings of the politician Anthony Crosland (1918-1977), who wrote:

> A dogged resistance to change now blankets every segment of our national life. A middle-aged conservatism, parochial and complacent, has settled over the country; and it is hard to find a single sphere in which Britain is pre-eminently in the forefront.[1286]

Crosland's writing was indicative of the declinist tone of a range of written literature that addressed the different narratives relating to the economic ails of Britain, and which laid most of the blame on a national decline.[1287] In his research Ortolano notes how the variation in the type of declinist literature ranged from the historical narratives such as the *British Economic Policy since the War* (1958) by Andrew Shonfield and Anthony

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[1281] UCS, *Forty-second Report of the Council* (1961-62), p. 26.
[1282] Sanderson, *The Universities and British Industry*, p. 364.
[1283] David Edgerton, 'The White Heat' Revisited: The British Government and Technology in the 1960s' *Twentieth Century British History* 7. 1 (1996), 53-82, (p. 57).
[1284] Guy Ortolano, *The Two Cultures Controversy* (Cambridge: Cambridge University Press, 2009), pp. 161-67.
[1285] Ortolano, pp. 161-67. For further reading on 'declinism' see: Jim Tomlinson, 'Inventing Decline:' The Falling behind of the British Economy in the Postwar Years' *The Economic History Review*, 49. 4 (1996), 731-757.
[1286] C. A. R. Crosland, *The Conservative Enemy. A Programme for Radical Reform for the 1960s* (London: Jonathan Cape, 1962), p. 127. Obituary (1977, February), Anthony Crossland Minister and Socialist Thinker, *The Times*, p. 12.
[1287] Ortolano, p. 165.

Simpson's *Anatomy of Britain* (1962) through to the popular Penguin series 'What's Wrong with Britain?' and satirical comments in *Private Eye*.[1288]

Crosland's comments merit attention as they reflect a national position exacerbated by the continuation of inequality within British society. In South Wales the lack of a logical and consistent regional strategy and a lack of commitment by successive governments during the 1950s and 1960s hindered regional prosperity.[1289] However, Crosland's argument on the need for social equality to further economic development especially in the area of education is laid out in his earlier revisionist book *The Future of Socialism* (1956).[1290] Later in the decade as part of the Harold Wilson administration Crosland would be appointed Secretary of State for Education and Science during the period 1965-67.[1291] It was these national concerns regarding the political and economic decline of Britain committed the Labour government and especially Harold Wilson towards a policy of modernisation.[1292] At the Party Conference at Scarborough in 1963 Labour's new leader Harold Wilson promised the British electorate a 'scientific and technological revolution'.[1293] Wilson's political discourse now famously referred to as the 'white heat' speech outlined a four-fold plan that not only addressed the age-old problem of insufficient numbers of scientists, but on re-directing scientific research towards industry.[1294]

In fact, Wilson's idea of the necessity of increasing connections between industry and academia had long been a policy of the University College of Swansea and had been a key factor in the founding of the institution. To further his ambitions for modernization Wilson's replaced the position of Minister for Science by a Ministry of Science with a full accompaniment of staff which would focus on delivering these aims.[1295] The creation of the cabinet post of Minister for Science had been an earlier innovative and key part of the Conservative government's plans for economic

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[1288] Ortolano, p. 165.
[1289] Wayne K. D. Davies, 'Towns and Villages' in *Wales A New Study* ed David Thomas (London: David & Charles, 1977), pp. 202- 203.
[1290] Giles Radice, 'Crosland and the Future of Socialism' in *Policy Network* (30 July 2010), www.policy-network.net>opinion [accessed 08 December 2018].
[1291] *The Times* (1977).
[1292] Ortolano, p. 167. For further reading on the Labour government and its policies during the 1960s see Steven Fielding, *The Labour Governments 1964-1970. Labour and Cultural Change* vol 1 (Manchester: Manchester University Press, 2003).
[1293] Harold Wilson, *Labour's Plan for Science* (I October 1963), www.nottspolitics.org/wp-content/uploads/2013/06/Labours_Plan_for_Science [accessed 18 July 2019].
[1294] Wilson, p. 5.
[1295] Wilson, p. 5.

modernization, with the first politician to occupy the role being Lord Hailsham, Quintin Hogg.[1296] The streamlining of bureaucracy within the Ministry of Education by the conservative administration of 1957-1964 was viewed with apprehension by the Committee of Vice-Chancellors.[1297] By early 1964 the office of joint permanent under-secretary for higher education had been dropped, thereby ensuring that the only senior state official dealing with higher education was a Minister of State. As D. C. Watt notes in his research that not only was this position a frequently changed post which could affect continuity of policy, it also placed the Minister in a powerful position to determine higher education policies.

In Watt's view the appointment in October 1964 of Crosland as Minister of Education who was both immensely confident in his political views and reluctant to engage in stages of consultation, was an example of how this arrangement could undermine the needs of universities.[1298] In his 1963 speech Wilson also drew attention to the lack of available university places as well as the inadequate use of universities, 'They [Lord Taylor's working party] recommend, and we accept, a crash programme, first, to make fuller use of existing universities and colleges of higher education.'[1299] In addition, Wilson determined that:

> - every one of us must accept, a tremendous building programme of new universities, and in this programme let us try and see that more of them are sited in industrial areas where they in some way reflect the pulsating throb of local industry, where they can work in partnership with the new industries we seek to create.[1300]

While, industrial/academic partnerships were not new in the history of university expansion, it was the level and breadth of the demand for science that surfaced during the second half of the Twentieth century. However, the group of new universities known as the 'Plateglass' universities established in the 1960s were not necessarily engaged with the policy of expanding courses in applied science and technology.[1301] Apart from Warwick's connection with automobile and electrical industries, most of the

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1296 Ortolano, pp. 182-83.
1297 D. C. Watt, 'The Freedom of the Universities. Illusion and Reality, 1962-69', in *Critical Survey* vol 4, no.3 (1969), https://www.jstor.org/stable/i40074943 [accessed 11 November 2016], p. 121.
1298 Watt, pp. 121-22.
1299 Wilson, p. 3.
1300 Wilson, p. 4.
1301 Sanderson, pp. 94-5.

institution's focus on the needs of industry were in creating management and economics courses.[1302]

Institutional Development – achieving a 'critical mass'.

While the political arguments regarding the expansion and independence of the constituent colleges of the University of Wales continued to occupy politicians and university administrators, academic scientific expansion in the Welsh institution continued at an increasing rate.[1303] Departmental growth at the Science Faculty at the University College at Swansea had reached a point where departments could undertake large collaborative research projects, a development noted by Professor E. S. Sellers who stated;

> I argue that forty years after its establishment the science faculty had achieved its 'critical mass' in relation to its established specialist research projects, as well as departmental involvement with international projects.[1304]

The term 'critical mass' deserves attention and is used in an article by the American sociologist David Riesman in the *Universities Quarterly* vol. 20 (1965-66) which discusses the themes underlying the comparative growth between American and British universities.[1305] The scientific term was used by Riesman to describe that point in the development of an academic department when it can support specialisation, both in terms of research and established extra-mural activities. In this context Riesman argues that the small size of some British universities had a restrictive effect on research development.[1306]

At the beginning of the decade 35 per cent of American young people went to university compared to only 6 per cent in Britain, yet the failure rate after the first year was as high as 40 or 50 per cent in some American universities.[1307] While, statistical evidence suggests that the British system had a more selective admissions process, the

[1302] Sanderson, p. 95. 'Plateglass' was the term coined by Michael Beloff which characterised their architectural design that was opposite the traditional design of the redbrick institutions. For further reading on the Plateglass institutions see: Michael Beloff, The *Plateglass Universities* (New Jersey: Associated University Press, 1970).
[1303] Morgan, pp. 108-9
[1304] Swansea University Library Pamphlets, Box no: LF1217, reference no: LF 1217.5.15, Professor E. S. Sellers, *Why Chemical Engineering* (Swansea: Swansea University Press, 1956).
[1305] David Riesman, 'Notes on New Universities: British and American' in *The Creation of a University System* ed. Michael Shattock (Oxford: Blackwell Publishers Ltd., 1996), p. 145.
[1306] Riesman, p. 145.
[1307] Vivian Bowden, 'Too Few Academic Eggs' *in The Creation of a University System* ed. Michael Shattock (Oxford: Blackwell Publishers Ltd., 1996), p. 82.

British attitude to course failure was very different to the American attitude. Student high failure rates were regarded by British universities as inefficient and a waste of resources, while American universities believed that even one completed academic year was of value to the student.[1308] The high expectation of potential students of British universities had been a check on the rate of the increase of student numbers. However, according to Riesman size was not the only issue relating to expansion in Britain's universities.[1309] While spending six months lecturing at the new Sussex University during the mid-1960s, Riesman visited 19 other universities and criticised the widespread traditional approach to planning university expansion. He was especially critical of how undergraduate degrees were planned. Riesman concluded that this rigid adherence to the traditional module of the university stifled planning innovations, while American university expansion during this period was defined by its flexibility.[1310]

As an overview of university planning Riesman's analysis appears to have credence. In fact, the research of historians of science such as John Ziman and Herbert Macgregor support the supposition that departmental planning in the 1950s and 1960s was established along traditional lines within the separate disciplines.[1311] Yet, the narratives of departmental planning in separate universities suggest a more complex reality. A crucial part of scientific expansion was conducted as an inter-disciplinary process which could shape future faculty developments. The opportunity for inter-disciplinary co-operation was evident at the University of Wales due to the structure of the degree courses.[1312] This is illustrated by the table below which shows the combination of subjects that could be taken with a Physics degree.[1313]

[1308] Bowden, p. 82.
[1309] Michael Shattock, 'The Creation of the British University System' in *The Creation of a University System* ed. Michael Shattock (Oxford: Blackwell Publishers, 1996), p. 9.
[1310] Shattock, p. 9.
[1311] John Ziman, 'The Mathematical, Exact Sciences' in *A History of the University in Europe* vol. IV ed. Walter Rüegg (Cambridge: Cambridge University Press, 2011), 424-449 (p. 429). Herbert C. Macgregor, 'The Biological Sciences', in *A History of the University in Europe* vol. IV ed. Walter Rüegg (Cambridge: Cambridge University Press, 2011), 451-472.
[1312] Swansea University Library Pamphlets, Box no: LF 1217, reference no: LF 1217.5.15, Professor J Dutton, *University Physics in Today's World* (Swansea: Swansea University Press, 1967), p. 12.
[1313]Special Collections and Archive, Cardiff University Library, Cardiff, *The Calendar of the University of Wales 1960-1961,* p. 51.

Figure 15. Combination of Subjects for a Physics Past Degree

Final Subjects	Subsidiary Subjects
Physics & Chemistry	Pure Mathematics
Physics & Geography	Pure Mathematics
Physics & Botany	Pure Mathematics, Chemistry, Philosophy, Geology, Zoology, Geography or Economics
Physics & Zoology	Pure Mathematics, Chemistry, Philosophy, Botany, Geology, Geography, Economics or Theory of Probability
Physics & Geology	Chemistry, Geography or Theory of Probability

Reference: Special Collections and Archives, Cardiff University Library, *University of Wales Calendar* (1960-61), p. 51.

As the Welsh science degree required the study of three subjects in the first year and the opportunity for General and Joint Honours degrees, the structure was able to react to opportunities across departmental boundaries.[1314]

As early as 1950 there is evidence of innovative collaborations within English universities, as revealed by the comments of Sir Harold Hartley, President of the British Association of the Advancement of Science.[1315] In an address at the University of Birmingham Hartley argued that within the university space it was made relatively easy for 'migrations' to occur from one department to another. Furthermore, Hartley noted that the 'cross-fertilisation' of one subject by another could also develop, and supported such developments at the Birmingham institution, stating that:

> You did not hesitate to introduce technology into the studies of your University. And why not, now that it is no longer based on the empiricism of utility but has its foundations firmly rooted in fundamental science? [1316]

Ziman argues that these traditional boundaries become more fluid as the diversity of the goals and problems of research increased, thereby encouraging closer contact between the sciences and associated technologies.[1317] A process illustrated by the developments in chemical engineering which were a consequence of inter-disciplinary research between chemistry and physics.[1318] Science rather than established technical practices

[1314] Dutton, p. 12.
[1315] Richard Burton Archives, reference no: UNI / SU / AS / 1 / 1 / 1, Sir Harold Hartley, *Address by Sir Harold Hartley* (1950).
[1316] Hartley.
[1317] Ziman, p. 433.
[1318] Ziman, p. 433.

were increasingly required to tackle the wide range of problems that arose from the growing chemical industry.[1319]

The range of problems required both applied chemists and applied physicists who had an 'engineering outlook'. Yet, as Sellers points out in his inaugural lecture at Swansea in 1956 that while the recent growth of chemical engineering as a distinct profession with its own boundaries was a positive development, it did pose problems when designing a university course.[1320] To encourage the diversity of studies within an established science discipline it was essential that staff numbers were adequate and had the varied skills to deliver specific sub-disciplines within a degree course. By the beginning of the 1960s the Geography department at the Swansea institution was successful in achieving such numbers of skilled staff.[1321] The ten scientists employed by the department had expert knowledge between them that covered historical, economic, human, industrial and agricultural geography, as well as climatology, geomorphology, cartography and photogrammetry. Furthermore, this expertise was connected to specific regions of the planet, with the overall knowledge of the department covering the British Isles, Europe, Africa, South Asia and North America.[1322]

Additionally during this decade, the number of new studies which had developed from the foundation studies of other established disciplines grew, and this led the Senate of the institution to propose new chairs in Inorganic Chemistry, Plasma Physics and Biochemistry.[1323] In addition, the number of Honours courses expanded as the selection of joint honours courses increased. By the end of the decade new joint honours courses offered in the natural sciences included: geography and zoology, biology and geography, biology and oceanography.[1324] Furthermore, psychology had been added to the honours course and could be studied with biology, genetics or zoology.[1325] Yet there was not continuous expansion during this period, as in 1965 the department of Geology ceased its formal contribution to the degree course in metallurgy.[1326] This decision to

[1319] Sellers.
[1320] Sellers.
[1321] Richard Burton Archives, reference no: Swansea University Misc., 665, W. V. G. Balchin, 'Department of Geography University College of Swansea' reprinted from *The Geographical Journal* vol. CXXVII, Part 1 (London: William Clovis and Sons Ltd., 1961).
[1322] RBA, 665, *Geography Department*.
[1323] Richard Burton Archives, Box no. 2013/21 (uncatalogued), Senate, *Consolidated Report on Academic Developments in the Quinquennium 1967-72* (May 1966), pp. iii-iv.
[1324] UCS, *Fiftieth Report of the Council* (1969-70), p. 138.
[1325] UCS, *Fiftieth Report,* p. 138.
[1326] UCS, *Forty-Fifth Report of the Council* (1964-65), p. 100.

cease including geology with the discipline of extraction metallurgy was to ensure that the undergraduate timetable in metallurgy was not overburdened.[1327] Regardless of the separation of geology and metallurgy, there needed to be further expansion and modernisation of the facilities of the science faculty at the Swansea institution to accommodate the developing disciplines.[1328]

Four decades from its establishment, the teaching and research facilities of the university college's science faculty had reached a critical point in providing adequate accommodation for the science disciplines. To continue with the expansion project of the campus a development fund was launched on 6 December 1960 with a target of £500,000, and by the end of six months £400,000 had been raised.[1329] The institution's established networks with industry yielded results again, as a large proportion of the money raised was from industrial sources.[1330] This fund was essential in financing the completion of the campus development, as the College's own financial reserves were few and the UGC insisted that the college had to contribute 5% towards the final cost.[1331] The community ethos of the science faculty was evident in the fundraising as a total of £6,500 was donated from the members of staff.[1332] However, as with the national trend the majority of the funding came from public funding. For the academic year 1962/63 the national public expenditure for higher education was £219 million, which was an enormous increase from the £7 million spent in the year before the onset of War II.[1333]

The plans for the Swansea campus were drawn up by the architect Sir Percy Thomas, which proposed a comprehensive extension of the Singleton campus.[1334] The architect also wished to develop the campus with a sympathetic bearing to the institution's surroundings, as he explains in his report:

> The college site is insulated from the suburbs by surrounding Park and the sea, free to develop its character almost undisturbed by influences of industrial Swansea. Already qualities of the academic precinct, and with its genius loci

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[1327] UCS, *Forty-Fifth Report*, p. 100.
[1328] Dykes, p. 172.
[1329] G. W. Roderick, 'Education in an Industrial Society' in *The City of Swansea Challenges & Change* ed. by Ralph A. Griffiths (Stroud: Alan Sutton Publishing Ltd., 1990), p. 191.
[1330] Roderick, p. 191.
[1331] Dykes, p. 177.
[1332] Estates Correspondent, 'Swansea College Fund reaches £400,000', *The Times*, 1962, 10.
[1333] Committee on Higher Education, *Higher Education Report of the Committee appointed by the Prime Minister under the Chairmanship of Lord Robbins 1961-63* (London: HMSO, 1963), p. 199.
[1334] Richard Burton Archives, reference no: Box no: 666, Sir Percy Thomas, *UCS Development Plan-Preliminary Report* (1958).

> established largely by Singleton Park. Future development should aim at the preservation and enrichment of these qualities. [1335]

Thomas' ambitions for maintaining the atmosphere of the Singleton site are laudable, but his report also includes an oblique reference to the accepted gulf between academic science and heavy industry. Yet, for the Natural Sciences the campus was conveniently sited for research, which is confirmed by the marine ecology studies and geographical field excursions that were undertaken by the science faculty since its first decade.[1336]

Throughout the sixties extensive building works transformed the Singleton site into a modern campus complete with new halls of residence.[1337] This phase of development led to the demolition of the 'temporary' science buildings which had been in use since their construction in 1922-1923.[1338] After over forty years the buildings had outgrown their use becoming 'inconvenient and unsightly', though their demolition symbolised the completion of the institution's development programme which had been initiated in 1959.[1339] Glass and concrete skyscrapers were constructed to house the physics and engineering departments, and the applied science departments were accommodated in a large building complete with tower and courtyard.[1340] At a cost of £3,800,000 the applied science building was the most expensive, as well as being the largest single building project to date at the Swansea University College.[1341] Construction work on the project began during the 1962-1963 session and as with an earlier project, the new library building, there was a collaborative aspect to the project.[1342] Internal expertise was used by the architects who worked closely with staff members of the Engineering department on the construction of the building.[1343]

The use of internal expertise was an opportunity which was not always utilised by the university college authorities, as explained by Professor D. V. Ager at his inaugural lecture in 1969.[1344] While suggesting that there was a 'world-wide neglect' of

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1335 RBA, 666, *UCS Development Plan*, p. 6.
1336 RBA, *Fifth Annual Report* (1925), pp. 11, 28-9.
1337 Morgan, p. 357.
1338 Richard Burton Archives, Box no. 2013/21 (4 of 8 uncatalogued), Estates Department, *Consolidated Report on Academic Developments in the Quinquennium 1967-72* (1966), p. ii.
1339 RBA / 2013/21, *Consolidated Report*, p. ii.
1340 Morgan, p. 108.
1341 Dykes, pp. 174-75.
1342 Dykes, p. 175.
1343 Dykes, p. 175.
1344 Swansea University Library Pamphlets, Box no: LF 1217, reference no: LF 1217.5.15, Inaugural Lectures 1947-1968, Professor D. V. Ager, *Geology as an Environmental Science* (Swansea: Swansea University Press, 1969).

geological advice on infrastructure projects Ager commented that: ‘a considerable sum (of money) might have been saved in building the present National Science Building if sufficient notice had been taken of the advice of an engineering geologist’.[1345] Ager’s criticism aside, there were serious problems that dogged the completion of the natural science building including an explosion and fire in 1961.[1346] It took until 1975 until the building housing the four natural science departments was finally completed.[1347] In addition to this major project which had begun in the fifties, the sixties decade of scientific expansion at the Swansea institution began with the construction of the chemistry building.[1348] The new chemistry building was officially opened on 1 May 1961 by the Professor of Organic Chemistry at the University of Cambridge, Sir Alexander Todd (1907-1997).[1349]

It was appropriate that Todd officiated at the opening as he was involved in the formation of public science policy, thereby playing a part in raising the profile and status of science to its zenith in the 1960s.[1350] Furthermore, Todd was awarded the Nobel Prize in 1957 for his work on the chemistry of the nuclei acids, which was work that led to the solution of the genetic code and the development of genetic science.[1351] Correspondingly, by the 1967-68 academic session a department of Genetics was established at the science faculty at the Swansea Institution.[1352] It was advantageous for the new and small department to be able to attract the experienced Professor J. A. Beardmore and appoint him as head of the department.[1353] Previous to his appointment at the Swansea institution, Beardmore expanded the Genetics department at the University of Groningen, The Netherlands. As the head of department Beardmore was successful in introducing new fields of research into a department whose facilities were limited. The significance of the geneticist’s work in various areas in the field of genetics which included the editing of the scientific journal *Genetica* was such that his move to Swansea was considered, ‘not a propitious one to genetics in The Netherlands, and the

1345 Ager.
1346 University College of Swansea, *Forty-First Report of the Council* (1960-1961), p. 78.
1347 Morgan, p. 108.
1348 UCS, *Forty-First Report*, p. 49.
1349 UCS, *Forty-First Report*, p. 49. John Cornforth, ‘Obituary: Lord Todd’ in *Independent*, https://www.independent.co.uk/news/people/obituary-Lord-Todd-1283405.html [accessed 27 July 2019].
1350 Cornforth.
1351 Cornforth.
1352 University College of Swansea, *Forty- Eight Report of the Council* (1967-68), p. 64.
1353 News and Views, ‘Genetics in University College, Swansea: Prof. J. A. Beardmore’ in *Nature* vol. 210 (1966), pp. 355-56.

move is a disappointment to Dutch colleagues'.[1354] With equal enthusiasm Beardmore successfully set up the department in Swansea, which accommodated 322 students and attracted visitors from the United States, Soviet Union, The Netherlands and British institutions during its first year.[1355]

The science faculty's research expansion into the field of genetics was made possible due to the provision of improved facilities. Similarly, the extension of teaching and research facilities in the new Chemistry building encouraged expansions in the discipline. The creation of specific laboratories for micro-chemistry, infrared and raman spectroscopy indicated the wide range of research across the discipline of chemistry that was already being undertaken at the department.[1356] The new building provided fully equipped extensive laboratory space over three floors with certain areas designated for teaching and research in organic and inorganic chemistry.[1357] While engineering, electronics and glass-blowing workshops were part of the practical facilities installed in the building, there were also specific rooms offering special facilities, such as a centrifuge room and a fire and flood laboratory.[1358] The available funding to establish these modern facilities for the Chemistry department ensured the further expansion, as well as the creation of new research projects in the future.[1359] In fact, within the first decade of the existence of the new Chemistry building, plans were put into place for a new laboratory wing and certain modifications to be made to some existing laboratories, which were completed in 1968.[1360]

New equipment was acquired specifically to expand particular research projects notably the study of antibiotic monomycin by the microbiological chemistry section which was sponsored by the National Research Development Corporation, and the kinetics of gas-phase reactions.[1361] The latter was a field of expertise that the recently appointed Professor of Physical Chemistry, Howard Purnell (1925-1996), established at

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1354 News and Views, p. 356.
1355 UCS, *Forty-Eight Report*, p. 64.
1356 Hopkins, pp. 964-65. Microchemistry is a teaching method of experimenting with small quantities of chemical substances. Raman and infrared spectroscopy are complimentary laboratory techniques used for fingerprinting molecules.
1357 Hopkins, 'University College of Swansea New Chemistry Laboratories' in *Nature*, vol. 190 (10 June 1961), pp. 964-65.
1358 Hopkins, pp. 964-65.
1359 Hopkins, pp. 964-65.
1360 UCS, *Forty-Sixth Report of the Council* (1965-67), p. 38. UCS, *Forty-Eighth Report of the Council* (1967-68), p. 57.
1361 UCS, *Forty-Sixth Report*, p. 38. Kinetics of gas-phase reactions are the study of chemical processes and rates of reactions.

the Chemistry department when he took up the post at the University College of Swansea in 1965.[1362] Purnell had been involved in a pioneering research programme at Cambridge alongside his friend and colleague John Knox (1927-2018) under the supervision of the Nobel Prize Winner Ronald G. W. Norrish (1897-1978).[1363] During his earlier career Purnell specialized in the field of gas-solid and gas-liquid chromatography, and his book, *Gas Chromatography* (1962) became a defining consultative guide for researchers globally.[1364]

A further phase of building construction was planned during this period to deal with rising student numbers, a situation which continued to put immense pressure on the traditional student lodgings within private residences in the town and the halls of residence on campus.[1365] The aim of the proposed plans was to provide further accommodation at the Hendrefoilan Estate, a site which was composed of Hendrefoilan House and 121 acres.[1366] The site was bought by the university college in June 1964, a move that had been considered necessary to support the expected expansion of the institution.[1367] However, it took until 1971 to begin the construction of residential accommodation to house 725 students, which was achieved gradually in three stages.[1368] To illustrate the pressures on student halls of resident student numbers had increased to the extent that by 1967 there were 1,000 students using college accommodation.[1369] Accommodation was not just needed for undergraduates, there had also been a substantial increase in the numbers of postgraduate research students from the enrolment of 68 research students during the academic year 1955-56 to 241 enrolled for the academic year 1964-65.[1370] Also, there was a cultural factor in the increase of students needing accommodation at their college, and that was the decline in Welsh students studying in their regional colleges.[1371]

1362 John Meurig Thomas, 'Obituary: Professor Howard Purnell', *Independent* (1996), [accessed 01 March 2019].
1363 Jack Davidson, 'Obituary: John Knox, world authority in the field of separation science', *Scotsman* (2018), https://www.scotsman.com [accessed 10 March 2019]. 'Ronald G. W. Norrish', *The Nobel Prize* (1978), https://www.nobelprize.org [accessed 10 March 1978].
1364 Thomas. Gas Chromatography is a common type of laboratory technique used in analytical chemistry for separating and analysing compounds that can be vaporised with decomposition.
1365 RBA / 2013/21, *Consolidated Report*, p. ii.
1366 RBA / 2013/21, *Consolidated Report*, p. ii.
1367 Dykes, p. 204.
1368 Dykes, p. 204.
1369 RBA / 2013/ 21, *Consolidated Report*, p. iii.
1370 RBA / 2013/ 21, *Consolidated Report*, p. iii.
1371 Morgan, *The University of Wales*, p. 102.

By 1963 only 51 per cent of students studying at the University College at Swansea came from Wales.[1372] These numbers were a far cry from the institution's first three decades when apart from a few individuals, the students came from Swansea and district and the accompanying regions.[1373] Regardless of the increase in student numbers The specifics of the students' origins are illustrated in the table below.

Figure 16: Distribution of New Students (men and women) at the University College, Swansea.

Region	1927 – 28		1929 – 30		1932 – 33	
	Arts	**Science**	**Arts**	**Science**	**Arts**	**Science**
West of Carmarthen	0	1	0	3	4	2
Llanelly and District	8	4	8	6	12	12
Pontardulais	0	1	0	1	4	1
Gowerton Area	1	3	10	2	18	7
Gower	3	0	2	0	5	4
Amman Valley	1	2	2	1	10	6
Tawe Valley	3	3	9	10	16	9
Swansea and District	22	22	40	17	43	36
Neath and District (including Neath Valley)	5	1	6	6	9	5
Port Talbot – Maesteg	3	5	4	8	1	8
E. Glam. and Monmouth	2	2	1	4	3	1
Others	4	5	2	3	7	3
TOTAL	52	49	84	61	132	94
	101		145		226	
Above totals include Part-time students	5	3	2	5	1	1

Richard Burton Archives, reference no: UNI / SU / AS / 1 / 1 / 79, Table I and II.

Yet, the Swansea institution was not alone amongst the colleges in witnessing a decline in Welsh students. In fact, Welsh student numbers at Swansea had decreased at the same rate as at Cardiff, with the university college of Bangor being the least satisfactory with only 28 per cent of its students being Welsh. The University College of Aberystwyth was the most successful of all the constituent colleges in attracting Welsh students with

[1372] Morgan, *The University of Wales,* p. 102.
[1373] Richard Burton Archives, reference no: UNI / SU / AS / 1 / 1 / 79, *Distribution of New Students Table 1 and 11* (1933?).

figures of 52 per cent.[1374] By the academic session of 1964-1965 students from Wales represented a minority of the student body in the Welsh colleges.[1375]

Declining Welsh student numbers at the University of Wales were observed at a time when the demography of Wales was rapidly changing. As Martin Johnes explains in his history of Wales, since the outbreak of World War II the number of people moving to Wales from different parts of England rose.[1376] In addition, there were increasing numbers of Welsh people moving to England. Johnes notes that nearly 55,000 people moved into Wales between the years 1961 and 1966, many who took up management and technical positions in the expanding commercial and industrial areas of South Wales. Furthermore, there were numbers of English working-class people moving into Wales, especially miners from the North of England whose mines had been closed and who filled vacancies in the mining industry in North Wales. While the incomers were welcomed, they were still regarded as culturally different and even if their children were born in Wales would continue to be regarded as English.[1377]

The change in the demographic make-up of certain regions of Wales also contributed to the increasing numbers of English students to the Welsh Colleges. This was a concern for the authorities and staff of the University of Wales who were worried about a decline in the Welsh character of the academic community in Wales.[1378] However, this was not a new issue. As far back as the University College of Swansea's first decade there was a concerted effort by the institution's authorities to emphasise and interpret Welsh history and culture to its English students and staff.[1379] Increasingly, cultural concerns were interconnected with the Welsh language debate, and the pressure to increase the official use of the Welsh language within the university.[1380] Throughout the sixties there was a demand by staff and students for bilingual forms, degree certificates, departmental letterheads and other official documentation.[1381]

[1374] Morgan, p. 102.
[1375] Morgan, p. 127.
[1376] Martin Johnes, *Wales since 1939* (Manchester: Manchester University Press, 2012), pp. 137-38.
[1377] Johnes, pp. 137-38.
[1378] Morgan, p. 127.
[1379] Richard Burton Archives, reference no: UNI / SU / AS / 2 / 1 / 117, Edwin Drew, *Letter to Mr. Ellicott* (10 January 1928).
[1380]Morgan, pp. 127-28.
[1381] Morgan, p. 128.

International Connections

While the 1960s was a difficult period for the University of Wales in maintaining the 'peace' within the federal system, the constituent colleges' scientific staff continued to maintain their links with each other's institution through the teaching Interchange Scheme.[1382] During the academic session of 1961-62 Professor T. W. Good, head of Agricultural Biochemistry at Aberystwyth, and Professor John Lander Harper from Bangor visited and lectured at Swansea University College through the Interchange Scheme.[1383] The scheme enabled the students of the four Welsh colleges to have access to a wider range of scientific expertise within the University of Wales. Expertise such as that of Harper (1925-2009) who was a leading authority in the field of plant ecology and was at the forefront of widening the field and linking the science of demography and selection.[1384] Opportunities for teaching and studying exchanges was not just limited to within the community of British universities. There had been an increasing desire during the post-war years to rebuild and strengthen contacts between universities in Britain and other European countries.[1385] The opportunities for students, post-graduate researchers and lecturers to visit and study at universities abroad grew throughout the 1950s.[1386] In Britain the Central Bureau for Educational Visits and Exchanges had supported official exchange schemes for students, and by the early 1960s that service was extended to teachers and lecturers.[1387]

While there was a movement to renew European educational connections between England and Wales and European countries, the political climate of the Cold War caused issues for those agencies arranging international visits to the German Democratic Republic (GDR).[1388] This is illustrated by the objection by the Foreign

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1382 Morgan, pp. 100-01. UCS, *Forty-Second Report of the Council* (1961-62), p. 50.
1383 UCS, *Forty-Second Report*, p. 53.
1384 R. Turkington, 'Professor John L. Harper FRS CBE (1925-2009)' in *Journal of Ecology* vol. 97 (2009), 835-837 (p. 835-6). In 1967 Harper's department of Agricultural Botany merged with the Department of Botany and became the School of Botany. This department became the nucleus of a research centre with Harper at its head. By the 1970s it had achieved an international reputation.
1385 Richard Burton Archives, reference no: UNI / SU / AS / 1 / 1 / 80, The British Council, *University Interchange between the United Kingdom and other European Countries 1948-1953* (London: The Westminster Press, n.d.), p. 5.
1386 RBA, UNI / SU / AS / 1 / 1 / 80, The British Council, pp. 5-6. A discussion on 'world-wide' university collaboration which includes international student visits and exchanges is to be found in the report by the British Association for the Advancement of Science, *Post-War University Education* (London: BAAS, 1944).
1387 The National Archives, Kew, reference no: FB2 / 16, Central Bureau for Educational Visits and Exchanges, *Minutes of Meeting* (11 July 1963), Item 2.
1388 The National Archives, Kew, reference no: FB2 / 13, Central Bureau for Educational Visits and Exchanges, Foreign Office, *Letter to the Chairman of the Cultural Relations Department* (11 December 1962).

Office to the Central Bureau's inclusion of the GDR as a destination in its publications, and who recommended its omission from future publications. The Foreign Office's opposition to students and lecturers visiting the GDR was political, in that the British state did not recognise the validity of the authorities or the state of the GDR.[1389] However, the response by the Central Bureau reminded the Foreign Office that 'the sole criteria for selection of material for its publications is that of the educational value without regard to political and other external considerations.'[1390] Official opposition to educational connections with communist countries was more focused during the sixties as the cold war intensified. Yet scientific visits between east and west did materialise as is evident in the fifth International Congress of Biochemistry in Moscow during 10-16 August 1961, which was attended by Dr Brown a lecturer in Biochemistry at the University College of Swansea.[1391] However, the timing of the congress was significant in that during the proceedings the building of the wall between east and west Germany was started, thereby furthering complicating plans for future collaboration with the West.[1392]

Previously, efforts were made to advance and strengthen East-West scientific connections by both European countries and the USSR, as the First International Conference on the Peaceful Uses of Atomic Energy reveals.[1393] The conference was held between 8-20 August 1955 at Geneva, and was significant as Soviet scientists attended and presented on Soviet atomic science and non-military technology.[1394] Furthermore, the spirit of international scientific co-operation was in evidence as is noted in the *Bulletin of the Atomic Scientist*, which states that they (the Russians):

1389 NA, FB2 / 13. For further reading on relations between Britain and the GDR see; Stefan Berger and Norman LaPorte, *Friendly Enemies: Britain and the GDR, 1949-1990* (Oxford and New York: Berghahn Books, 2010).

1390 The National Archives, Kew, reference no: FB2 / 13, Cultural Relations Department, *Letter to the Foreign Office* (7 January 1963).

1391 UCS, *Forty-First Report*, p. 38.

1392 B. E. C. Slater, 'The History of IUB (MB)' in *Life* 57 (4/5) (2005), 203-211, https://iubmb.onlinelibrary.wiley.com/doi/pdf/10.1080/15216540500128098 [accessed 08 July 2019], p. 204. For further reading on the complexity of scientific networks during the Cold War using new source material from former communist countries and western countries see: Alison Kraft, Holger Nehring and Carola Sachse, eds., 'The Pugwash Conferences and the Global Cold War Scientists, Transnational Networks, and the Complexity of Nuclear Histories' *Journal of Cold War Studies,* Special Issue, vol. 20. 1 (2018).

1393 Swansea University Library Pamphlets, Box no: LF 1217, reference no: LF 1217.5.15, Professor E. S. Sellers, *Why Chemical Engineering* (Swansea: Swansea University Press, 1956), p. 13.

1394 Eugene Rabinowitch, 'First International Conference on Atomic Energy Geneva, August 8-20, 1955' *Bulletin of the Atomic Scientists* vol. 11. 8 (1955), p. 274, https://tandfonline.com/doi/pdf/10.1080/00963402.1955 [accessed 06 July 2019], p. 274.

> … felt themselves free to mingle with their Western colleagues and to resume with gusto the tradition of free international discussion of problems of common interest which has been one of the greatest joys of scientific life in the past.[1395]

Scientific connections between the USSR and Britain continued as a Russian delegation visited Britain following the conference, which was reciprocated by a British delegation of scientists visiting the USSR.[1396]

Yet, there is evidence that the nationality and the political views of some scientists curbed their ability to travel and work in other countries.[1397] In his book *Elemental Germans*, Christoph Laucht discusses the reasons behind the security measures that prevented foreign-born scientists, especially those of German origin in obtaining US visas. Laucht's research also states how certain scientists with left-wing or communist views were refused passports or had them confiscated. This was also happening in Britain, but on a much smaller scale.[1398] Regardless of individual official disruption, the second International Conference organised by the International Atomic Energy Agency (IAEA) held in 1958 was substantially larger than the first, with 2,135 papers submitted compared to the 1,067 presented to the 1955 meeting.[1399] One paper entitled *Controlled Nuclear Fusion Research in the UK* was given by a British delegate, Professor Peter Thonemann (1917-2018), the Principal Scientific Officer in the General Physics Division at the Atomic Energy Research Establishment (AERE), Harwell.[1400] Thonemann's pioneering work on fusion research resulted in the building of the fusion reactor ZETA (Zero-Energy Toroidal Assembly) which went into operation in 1957.

1395 Rabinowitch, p. 274.

1396 Sellers, p. 13.

1397 Christoph Laucht, *Elemental Germans, Klaus Fuchs, Rudolf Peierls and the Making of British Nuclear Culture 1939-59* (Basingstoke: Palgrave, 2012), pp. 110-124. For further reading see: Jessica Wang, *American Science in an Age of Anxiety* (Chapel Hill and London: The University of North Carolina Press, 1999).

1398 Laucht, p. 110. For further reading on the West's perception of communism see: Weston Ullrich, "Preventing Peace": The British Government and the Second World Peace Congress', *Cold War History*, 11. 3 (2011), 341-362. For further reading of anti-communism in the US and Britain see: Giora Goodman, 'The British Government and the Challenge of McCarthyism in the Early Cold War', *Journal of Cold War Studies*, 12. 1 (2010), 62-97.

1399 International Atomic Energy Agency, *The Geneva Conference – How it all began*, https://www.iaea.org>files>publications>magazines>bulletin>bull6-3/06305100303.pdf [accessed 27 August 2019], p. 3.

1400 Swansea University, *Professor Peter Thonemann – A Reflection of his Life* (2018), https://www.swansea.ac.uk>TheUniversity [accessed 27 August 2019]. Obituary (2018, April), Brian James, *Sydney Morning Herald.* For further reading on the history and science undertaken at Harwell see: Ministry of Supply and the Central Office of Information, *Harwell. The British Atomic Energy Research Establishment 1946-1951* (London: HMSO, 1952. K. E. B. Jay, *Atomic Energy Research at Harwell* (London: Butterworths Scientific Publications, 1955).

Just over a decade later Thonemann joined the scientific community at the Swansea institution as head of the Physics department. Unable to obtain research council funding to establish fusion research at the Swansea institution Thonemann collaborated with the Biology department researching aspects of the behaviour of the bacterium E. coli.[1401]

Between 1948 and 1953 there is no evidence of any lecturers from any of the four constituent Welsh colleges attending short exchange teaching visits to Europe arranged by the British Council.[1402] However, a decade later the science faculty of the Swansea institution had established strong links with overseas universities, and international connections were maintained by teaching staff visiting overseas institutions.[1403] Leave of absence was given to teaching staff whose visits were undertaken during term time or were for an extended period, such as the year's absence granted to Dr H. E. Hallam (1925-1977) of the Chemistry department.[1404] However, Hallam's visit to the University of Nigeria was more than a teaching exchange, as his expertise was used to advise on Physical Chemistry in the newly created University of Nigeria at Nsukka.[1405] Hallam had previous experience of working in Africa during his early career, when he accepted a lecturing post at the University of Khartoum.[1406] Throughout his academic career Hallam conducted research on infra-red studies of molecular structure and inter-action, and became internationally recognised for his work in matrix media in this area of research.[1407]

Another overseas advisory visit by a member of staff was undertaken by the head of the Chemistry department, Professor Cedric Herbert Hassall, who spent time at Malta as a member of the Commission which appointed by the Government of Malta.[1408] The Commission was set up to advise the Royal University on certain issues.[1409] Born in Auckland New Zealand, Hassall had an international outlook to science and was closely involved with international scientific communities and learned societies, such as the Caribbean Research Council and the Government Grants Committee to Sierra

[1401] James.
[1402] RBA, UNI / SU / AS / 1 / 1 / 80, *The British Council*, pp. 5-6.
[1403] UCS, *Forty-Sixth Report*, p. 112.
[1404] UCS, *Forty-Third Report*, p. 33. Obituary (1977, May), Dr H. E. Hallam, *The Times,* p. 18.
[1405] UCS, *Forty-Third Report*, p. 33.
[1406] *The Times*, p. 18.
[1407] *The Times,* p. 18.
[1408] UCS, *Forty-Third Report* (1962-63), p.33.
[1409] UCS, *Forty-Third Report*, p. 33.

Leone.[1410] Significantly, his post as the first professor of Chemistry at the University College of the West Indies between 1948 till 1956 coincided with Principal Parry's time at that institution (1949-1956).[1411] Even though both academics worked in different faculties it is rather likely that they would have known one another as the institution had only just been established in 1948, and as such would have had limited facilities and staff.[1412]

Links with overseas institutions were fostered by the increasing numbers of visits from their scientific teaching and research staff. By the middle of the sixties the science departments of the Swansea institution were linked into an international scientific academic network that stretched around the globe.[1413] The diagram below illustrates how diverse and far-reaching the connections that had been established or developed by the individual science departments during one academic year.

Figure 17: Visiting Students from Abroad during Academic Year 1965-1966.

Department	Number of Students	Country
Botany	4	USA, France, India
Chemical Engineering	3	South Africa, Romania
Chemistry	3	Tasmania, USA
Geography	5	Russia, Yugoslavia, New Zealand, South Africa
Geology	10	Germany, Australia, USA India, Holland, Poland, Japan
Physics	7	Japan, Switzerland, France, USA
Zoology	0	N/A
Metallurgy	0	N/A

Reference no: UCS, *Forty-Six Report of the Council* (1965-66)[1414]

However, the fact that the Metallurgy and Zoology departments did not receive visitors from overseas institutions that year does not imply that these departments were not in touch with their contemporaries abroad. The Metallurgy department had a visit from

[1410] Biographies, 'Hassall, Cedric Herbert' in *An Encyclopaedia of New Zealand Expatriates* (1966), https://teara.govt.nz/eu/1966/expatriates-biographies [accessed 13 July 2019], p.32.
[1411] Biographies, p. 32. Boxer, p. 153.
[1412] Home Page, *The University of the West Indies at Mona, Jamaica*, https://www.mona.uwi.edu/content/history [accessed 19 July 2019]. The University College was established in 1948 to serve the area of the Caribbean. Its early accommodation was in barrack style buildings left over from WW11.
[1413] UCS, *Forty-Six Report* (1965-66).
[1414] It is noted in the institution's diagram that the names of the countries Tasmania and Germany are technically inaccurate, and should read Tasmania, Australia, and Germany should read the Federal Republic of Germany or the German Democratic Republic or both.

metallurgists from Australia during the following academic year, while the department of Zoology had academic visitors from France, Belgium and the USA the previous academic session of 1964-65.[1415]

There were also increasing numbers of post-graduates visiting the different departments of the science faculty to take up research fellowships that were being offered by the Swansea institution. The research Fellowship posts that were offered during the 1960s by the science faculty were wide-ranging in their topics and were provided by all the science departments. An example of the broad range of research posts being offered to overseas research students are illustrated by two posts offered by the Metallurgy department during the academic session of 1965-66: T. W. Barnes of the University College of Wollongong, New South Wales, Australia, was given a one year post to research the determination of solidification boundaries by ultrasonic technique, and Dr Z. Bojarski of the Institute of Ferrous Metallurgy, Gliwice, Poland, who studied the Ausforming of Maraging Steel (a steel alloy used extensively in the aerospace industry).[1416] Ausforming was also known as the Low and High temperature thermomechanical treatment, a method which shaped and refined the microstructure of steel to increase the alloy's hardness and toughness.[1417] In another discipline, Zoology, research student C. A. Hussein from the Government College of Lahore was involved with a project studying the thermal sense of locusts, while a colleague, M. A. Khan from Osmania University was part of a team investigating the scent organs of moths.[1418]

Visits by overseas scientists to the science faculty were not just confined to research studies, there was also increasing numbers of visitors from overseas institutions who were specifically interested in the Natural Sciences Building, and particularly the department of Geography.[1419] The construction of the Natural Sciences building was recognised by geographers as an important step in the development of the discipline, and attracted interest from academic institutions as far away as Australia and New Zealand.[1420] The importance of the Swansea institution's building and curriculum

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[1415] UCS, *Forty-Seventh Report of the Council* (1966-67), p. 65. UCS, *Forty-Fifth Report*, p. 133.
[1416] UCS, *Fortieth-Sixth Report*, p. 103. ScienceDirect Topics, *Managing Steel – an overview* (2012), https://www.sciencedirect.com/topics/materials-science/maraging-steel [accessed 22 August 2019].
[1417] Erhard Hornbogen and Karl Ritter, 'Development of thermo-mechanical treatments of a maraging steel for yield strengths above 3GPa' in *Steel Research* vol 58 (1987), https://onlinelibrary.wiley.com/doi/abs/10.1002/srin.198700857 [accessed 22 August 2019].
[1418] UCS, *Forty-Seventh Report*, p. 87.
[1419] UCS, *Forty-Third Report of the Council* (1962-63), p. 65.
[1420] Richard Burton Archives, Box no: 583, W. V. G. Balchin, University College of Swansea (1960?). UCS, *Forty-Third Report* (1962-63), p. 65.

development in the natural sciences is borne out by the fact that by 1966 a total of 47 universities and institutions from across the global academic community had visited the Natural Sciences Building.[1421] While there was an interest in the facilities offered for the different disciplines and the structure and development of the Geography courses, there was also great interest in the design of the building.[1422]

The main part of the structure was completed in 1956 when there was little university building in Britain, and it represents an early post-war example of a purpose built university teaching premises.[1423] The rarity of such educational building work at this time would in itself have attracted visitors, especially as it was part of a radical plan to develop a residential campus based institution. Yet, the striking exterior of the Natural Sciences Building with its band of panels containing cast emblems symbolising the four sciences, geography, geology, botany, and zoology was, and still is an attraction for visitors. In addition to the low-relief designed panels, the use of concrete on the exterior represented ‘a bold and highly disciplined essay in a modern-traditional style’.[1424] The Natural Science Building is an example of post-war university campus growth that adopted well-organised planning and distinguished architecture, a development which studies have revealed can have a positive impact on the academic experience of students.[1425]

The scientific academic networks that had been created and developed by scientists at the Swansea institution continued to be extended during this period. As illustrated by the Physics department academic session of 1965-66 who received visits from physicists from France, Japan, USA and the international research laboratory CERN (European Organisation for Nuclear Research) which was sited across the France-Swiss border near Geneva.[1426] A post-war European project CERN was an example of ‘Big Science’ as discussed in chapter five. The facility’s foundation in 1954 was an international effort by 12 states to establish the first European atomic physics

[1421] UCS, *Forty-Sixth Report*, p. 80.
[1422] UCS, *Forty-Third Report*, pp. 65-6.
[1423] CADW, ‘Wallace Building’, *British Listed Buildings* (12 March 2004), https://britishlistedbuildings.co.uk/300082443.wallace-building-sketty# [accessed 01 October 2020]. The Natural Science Building was awarded the status of a Grade 11 listed building on the 12 March 2004. It is now known as the ‘Wallace Building’, named after the ‘father of biogeography’, Alfred Russel Wallace, the nineteenth century Welsh evolutionary biologist.
[1424] CADW, ‘Wallace Building’.
[1425] Stefan Muthesius, *The Post-War University Utopianus Campus and College* (London: Yale University Press, 2000).
[1426] UCS, *Forty-Sixth Report*, p. 112. The abbreviation CERN is derived from the French title Conseil Européen pour la Recherche Nucléaire.

laboratory, and this collaborative approach continued with the funding, managing and the use of the facility.[1427] Britain's initial response to this international project was cautious, as not only were there international disagreements over the siting and the structure of the proposed laboratory, the Treasury department opposed committing to a European project which had no predetermined end.[1428] Regardless of initial concerns Britain became a founding member of CERN, and then proceeded to be a full member of the project.[1429]

Over the following decades the Swansea institution's link with the research facility, CERN, would develop into a close working relationship giving staff members of the Physics department an opportunity to undertake research for lengthy periods of time at the facility.[1430] The relationship between CERN and the Physics department was a two-way collaboration, as staff involvement with research undertaken at the research laboratory created specific research projects at the Physics department. This was the case when Dr C. Grey-Morgan was awarded a grant of £10,705 over a 3 year period by the Science Research Council during the academic year of 1965-66.[1431] Grey-Morgan was awarded the grant to research the interaction of intense laser radiation with matter, which was an area of research that was closely related to the work that he had initiated at CERN. This was research that Grey-Morgan had undertaken while he was working at the facility as the Visiting Scientist in the Nuclear Physics Apparatus Division, which had been a yearly appointment.[1432] Grey-Morgan's research was also closely associated with the theoretical work that was being taught in the Physics department. CERN offered research opportunities to postgraduate students as well as providing fellowship posts, a position which one postgraduate student from the Physics department Dr Eifionydd Jones had accepted in 1959.[1433]

Community Links and Collaborative Research

The University College of Swansea's links with the wider industrial and commercial community of Swansea and its region were extended during the 1960s through the

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[1427] CERN: *Home Page,* https://home.cern/about. For further reading on the history of CERN see: Peter Galison, 'Fortran, Physics and Human Nature' in *The Invention of Physical Science* ed. by Mary Jo Nye, Joan L. Richards, Roger H. Stuewer (New York: Kluwer Academic Publishers, 1992).
[1428] Agar, p. 363.
[1429] Agar, p. 363.
[1430] Dykes, p. 215.
[1431] UCS, *Forty-Sixth Report,* p. 109.
[1432] UCS, *Forty-Sixth Report,* p. 111.
[1433] West Glamorgan Archives, Box no: JO – M, File 1, Dr Eifionydd Jones (11 May 1959).

creation of research projects which reflected the major changes that were taking place in the industry of South Wales.[1434] The Swansea institution had previously responded to research needs by extending certain scientific disciplines and establishing new chairs, such as in 1955 when chemical engineering and physical metallurgy were established in the department of Metallurgy.[1435] Financial support to establish the chair for Physical Metallurgy came from Welsh industry, the Steel Company of Wales and Messrs. Richard Thomas & Baldwin Ltd.[1436] While physical engineering remained in the department of Metallurgy, by the academic year of 1968-69 the department of Chemical Engineering had grown to accommodate 3 senior lecturers and 7 lecturers under a professor.[1437] Throughout the decade of the sixties there continued to be discussions relating to encouraging closer understanding between industry and academia. One critical element of such discussions was the complex question of communication between the academic and industrial communities, and to that effect a two-day conference was held at the University College of Swansea during April 1961.[1438] The conference, which was organised by the DSIR, were presented with papers from academic scientists as well as research organisations such as the Scottish Council for Development and Industry and the British Iron and Steel Research. The papers and the varied discussions at the conference illustrated the complexity of improving and developing communications between scientific and technical researchers and the many sectors of academia and industry.[1439]

While the efforts to improve communications between academia and industry continued at a national level, the historic connections between the science faculty at the Swansea institution and the region's industry made contemporary efforts to engage in practical solutions easier. Specifically, one local initiative enabled lecturers to gain an insight into the industrial problems which faced scientists who worked in commercial metallurgy.[1440] The initiative involved the secondment of a lecturer at the Metallurgy department for a year to an industrial plant of the Steel Company of Wales. The

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1434 Gareth Elwyn Jones and Gordon Wynne Roderick, *A History of Education in Wales* (Cardiff: University of Wales, 2003), p. 165.
1435 UCS, *Thirty-Fifth Report to the Council* (1954-55), p. 118. UCS, *Thirty-Sixth Report to the Council* (1955-56), p. 132.
1436 UCS, *Thirty-Sixth Report*, p. 132.
1437 UCS, *Thirty-Ninth Report of the Council* (1968-69), pp. 20 and 24.
1438 E. E. Williams, 'Science and Industry – The Problem of Communication' in *Nature* vol. 190 (1961), 965-966 (p. 965).
1439 Williams, p. 966.
1440 UCS, *Forty-Fifth Report*, p. 101.

secondment was made possible by an agreement that was reached by the Metallurgy department and the Steel Company, in which the company would financially support an extra lecturer in the department to cover the seconded staff member. The agreement covered a period of 5 years which gave 5 members of staff this unique opportunity.[1441] Furthermore, national concerns over the lack of further training opportunities for industrial scientists prompted the Science Research Council to initiate two schemes to address this educational shortfall, as well encouraging closer connections between industrial and academic science.[1442]

One of the schemes was the introduction of industrial studentships which was initiated in October 1966.[1443] Research studentships were already in place within the academic sphere which were financially supported by government agencies and industry, and by 1960 there was an increasing availability of such awards.[1444] Consequently, there was an increase in the numbers of students who were supported by such grants at universities, including the science departments at the Swansea institution.[1445] The difference with the new scheme was that the studentships were available for scientists who were already working within industry, and who wished to obtain further training and postgraduate degrees.[1446] The candidate for a studentship had to have been working in the profession for at least a year, as well as being academically acceptable to both the Science Research Council and the intended institution. The second scheme gave an opportunity for undergraduates to gain industrial experience before going on to undertake a post-graduate course, by giving an individual a guarantee of financial support which was available for up to 5 years after graduation. In addition, the structure of both the Science Research Council schemes allowed the industrial employers to give added financial support to the candidates. This was particularly useful for the studentship programme where the candidate would not lose his professional income.[1447]

As well as engaging with industrial research science departments at the Swansea institution also became involved with environmental projects. Two projects which tackled specific environmental issues had important consequences for Swansea and the

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[1441] UCS, *Forty-Fifth Report*, p. 101.
[1442] News and Views, 'Grants for Industrial Sciences' in *Nature* vol. 21 (1996), p. 356.
[1443] News and Views, p. 356.
[1444] UCS, *Fortieth Report of the Council* (1959-60), p. 43.
[1445] UCS, *Fortieth Report*, p. 43.
[1446] News and Views, p. 536.
[1447] News and Views, p. 356.

surrounding region. Both projects involved staff and research students at the department of Geology, one focused on coastal marine pollution while the other was an environmental clean-up of the Lower Swansea Valley area. The department of Geology had developed into the largest science department of the Swansea institution's science faculty in terms of student numbers which amounted to over 300.[1448] Yet, even with 16 members of teaching staff and 21 technical and administrative staff the department still had to catch up with other science departments on the Singleton campus in terms of numbers of staff, as well as income and departmental space. However, two main developments set the Geology department at Swansea apart from corresponding departments at other universities; 1) an extensive Honours course which was recognised as the largest in Britain, 2) the establishment of a sub-department of Oceanology which was unique in its research of the geological and environmental aspects of the sea and the sea-shore.[1449]

The position of the Swansea campus yards from the shoreline of the Swansea bay placed the geology department in an ideal place to establish research projects which could address coastal and marine issues. Yet, the creation of a local environmental project was a collaborative process between academia and the regional authorities, as the head of the department, Professor Ager noted:

> We have a large geology department including our school of oceanography, both staffed with experts and any research students amply qualified to work on all the kinds of environmental problems I have mentioned. Have not the regional authorities themselves the duty to make use of these facilities in the service of the community?[1450]

The most notable research projects addressed the serious issues of coastal sea pollution due to untreated sewage and heavy metals and the neglect of Swansea Bay, which was in danger of turning into mudflats due to the continual commercial use of sand from the foreshore.[1451] Further marine research was undertaken in collaboration with the Ministry of Agriculture, Fisheries and Food. A small research group from the oceanography school began a series of water sample tests so as to study the dispersion

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[1448] Swansea University Library Pamphlets, Box no: LF1217, Inaugural Lectures 1969-1994, reference no. LF1217.5.15, Professor D.V. Ager, *Geology as an Environmental Science* (Swansea: Swansea University Press, 1969), p. 3.
[1449] Ager, p. 3 and 11.
[1450] Swansea University Library Pamphlets, Inaugural Lectures 1969-1994, reference no: LF 1217.5.15, D. V., Ager, *Geology as an Environmental Science* (1969), p. 12.
[1451] Richard Burton Archives, reference no: UWS Swansea University Misc., 2 of 3, University College of Swansea, *Principal's Address to the Court of Governors* (29 November 1968), p. 6. Ager, p. 12.

of any radioactive waste in the Bristol Channel from the nuclear power stations, Berkeley and Hinkley Point A, that were sited on the Severn estuary.[1452] The evolution of the Sub-department of Oceanology at Swansea dates back to the 1950s, when there was increasing interest in marine science, and the university college's response was reflected in the inclusion of marine ecology in the Zoology courses.[1453] To further the development of the sub-department the college had appointed an expert in Marine Biology, Dr E. W. Knight-Jones as the head of the new Zoology department in 1956.[1454] Knight-Jones' previous post was as deputy director of the Marine Biology Station which had been established by the University College of Bangor in 1953.[1455]

By the end of the decade there were plans to develop the sub-department of Oceanology into a Centre for Marine Biology at the University College of Swansea.[1456] The college's objective was supported by the UGC whose working party on Marine Biology recommended that a capital grant of £7,500 be awarded to the institution with a further additional recurrent grant of £3,500 per annum for the financial years 1970/71 and 1971-72.[1457] The UCG grant was used to requisition and refurbish a trawler, the S. S. Ocean Crest, and acquire three smaller inshore boats were to assist the S. S. Ocean Crest [1458] These vessels were essential to the department in providing teaching and research into Oceanology and Marine Biology and proved to be an invaluable asset in teaching undergraduates and research students in practical oceanology.[1459] By September 1968 the department's first detailed marine survey on a section of the Glamorgan coast was published, which included approximately 100 miles of seismic profiles and 116 sample stations.[1460] From its inception the programme of oceanology research at the Swansea institution were a multi-disciplinary team that included

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[1452] Ager, p. 12. By this period the nuclear power stations operating in the Bristol Channel area were Berkeley in Gloucester by the river Severn commissioned in1957 and connected to the grid in 1962, and Hinkley Point A in Somerset commissioned in 1957 and connected to the grid in 1965.
[1453] Swansea University Library Pamphlets, Box no: LF1217, Inaugural Lectures 1969-1994, reference no: LF1217.5.15, Professor J. S. Ryland, *Neptune's Realm Explorations in Marine Biology* (Swansea: Swansea University Press, 1978)
[1454] Dykes, p. 167.
[1455] Ryland.
[1456] UCS, *Fortieth Report* (1959-60), p. 142.
[1457] UCS, *Fortieth Report*, p. 142.
[1458] RBA, reference: UWS/ Misc., 2 of 3, *Principal's Address*, p. 6.
[1459] RBA, UWS / Misc., 2 of 3, p. 6.
[1460] UCS, *Forty-ninth Report to the Council* (1968-69), p. 66.

geologists and geophysicists, and expanded to include the expertise of zoologists and geneticists by the end of the decade.[1461]

The establishment of inter-disciplinary research which addressed specific regional marine environmental issues was an example of a collaborative community, yet another project that addressed the negative environmental issues of the region's industrial past represented an epistemic community. The epistemic community differed from the broader scientific community as the attainment of knowledge to assist change or influence policies was the ethical shared goal of the individuals working within the group.[1462] These conditions describe the framework of an enterprise which became known as The Lower Swansea Valley Project.[1463] During the early 1960s John Parry, principal of the University College of Swansea played a seminal lead in the planning of the project, as he was aware that the proposal of such a large undertaking gave the institution an opportunity to be part of a large inter-disciplinary study.[1464] Under Parry's leadership heads of departments joined representatives of the Borough Council, the Welsh Office and local industry to set up a working party to define the aims of the project and organise funding. In 1961 the collaborative enterprise was formally established with Kenneth Hilton appointed as the executive Director.[1465]

In the project's early stages, there was a consensus between the different participators regarding the direction of the project, however, there is evidence of disagreements relating to planning details at a local government level. The local authority in Swansea had been closely involved with the project from its inception, but as Hilton infers in his letter to M. E. Taylor, County Planner for Fife, that:

> Swansea is not planning-minded, only because the Councillors as a whole do not really understand what it means. If you visit and explain problems in Fife they will more readily understand.[1466]

[1461] Swansea University Library Pamphlets, Box no: LF 1217 Inaugural Lectures 1947-1968, reference no; LF 1217.5.15, Professor Philip Joseph Syrett, *The Science of Plant Biology* (Swansea: Swansea University Press, 1968), p. 14.
[1462] Peter M. Haas, *Epistemic Communities, Constructivism, and International Environmental Politics* (London and New York: Routledge, 2016), pp. 84-5.
[1463] K. J. Hilton, 'How the Project came about and what it was intended to achieve' in *The Lower Swansea Valley Project* ed. by K. J. Hilton (London: Longmans, Green and Co Ltd., 1967), pp. 1-2.
[1464] Hilton, pp. 1-2.
[1465] Hilton, p. 2.
[1466] RBA, SUC / LAC / 69 / E3, *K. J. Hilton, Letter to M.E. Taylor, County Planning Officer, Fife* (April 1963).

Hilton hoped that if councillors were aware of the success of similar projects then they would be more confident in supporting the Swansea reclamation project.[1467]

Indeed, the Swansea project was complex and of a substantial size, however there was the added complication that a sizable percentage of the proposed reclamation was in private ownership and by different industries.[1468] This situation was due to the historic development of the site of the Lower Swansea Valley which had been a world metallurgical centre accompanied by various secondary industries for over two hundred years.[1469] However, the gradual decline of the tinplate industry and the modernisation of the steel industry meant that by the mid Twentieth-century the industrial valley had been reduced into the largest area of industrial dereliction in the United Kingdom. The area of dereliction covered 700 acres, and amongst the dilapidated buildings over seven million tons of slag and furnace waste had been deposited in high heaps exceeding 60ft. Since 1912 previous schemes to address the specific problems of the area's regeneration had come to nothing, due to the untimely intervention of both World Wars and limited financial assistance for clearing derelict industrial sites.[1470]

By 1960 there were still industrial plants operating in the Lower Swansea Valley, but they occupied less than 20% of the area.[1471] These older heavy industries employed several thousand workers.[1472] Furthermore, there were thousands of residents who lived alongside the dereliction and breathed in the atmospheric pollution.[1473] The air quality was so poor that the Medical Officer of Health was concerned over the consequences of the air pollution in the area.[1474] The desolation of this area of Swansea was not a hidden blight to visitors, as the main railway lines were routed through the valley and its dereliction was in full view of train passengers. It was on one of the regular train journeys from Swansea to London that Robin Huws Jones (1909-2001), Director of Social Sciences at the University College of Swansea noted the concerns of fellow passengers on the state of the area.[1475] Jones decided that a new initiative had to put into

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[1467] RBA, SUC / LAC / 69 / E3, *Letter to M. E. Taylor.*
[1468] RBA, SUC / LAC / 69 / E3, *Letter to D. W. Riley*.
[1469] K. J. Hilton, 'The Lower Swansea Valley Project' in *Swansea and its Region* ed. by W. G. V. Balchin (Swansea: University College of Swansea, 1971), 365-382 (p. 367).
[1470] Hilton, *Swansea and its Region*, p. 368.
[1471] R. D. Worrall, *Report on Transportation and Physical Planning in the Lower Swansea Valley* (Swansea: University College of Swansea, 1963), p. ix.
[1472] Hilton, p. 6.
[1473] Hilton, p. 6.
[1474] Richard Burton Archives, Swansea University College, reference no: LAC / 69 / E3, K. J. Hilton, *Letter to Mr. Watkins, Town Clerk* (October 1961).
[1475] Obituary (2001, July), 'Robin Huws Jones', *The Times*, p. 17.

action to recognise and solve the area's problems, and consequently established and became a founder member of an integrated rehabilitation plan for the area known as the Lower Swansea Valley Project.[1476]

This proved to be a seminal research project for the science faculty, as well as being a timely opportunity to showcase the new facilities and laboratories of its modernised science departments. However, the project was multidisciplinary in its research and encompassed socio-economic studies as well as pure and applied science.[1477] Furthermore, it became a very public study with continuous updates in the regional media, as well as reports in the national media such as the 10-minute slot on the BBC television programme '*Standpoint*'.[1478] The project was highlighted in a BBC discussion on *Atmosp*heric *Pollution* and a documentary *Landscape with Clinker*.[1479] At a regional level Miss D. John followed the progress of the project on the Welsh Home Service Programme 'The Welsh Garden'.[1480] The relationship between the media and the Swansea Valley Project exemplified the level of communication that Dr T. Margerison (1923-2014), the first science editor of the *Sunday Times,* believed was needed for the interpretation of science to the public.[1481] Margerison's views on the value of using all aspects of the mass media to promote an understanding of scientific and industrial developments were aired at the conference on communication in science, which was held at the Swansea institution in 1961.[1482]

The network of scientists, industrialists and civil servants that was established in Swansea to set up research studies that were pertinent to the Lower Swansea Valley Project was widened nationally to include individuals with expertise that could support the project. Professor Street, head of the Biology Department established connections with scientists who had worked on a similar project in Lancashire, and visited the project with another member of staff, Dr Goodman to assess the reclamation and

[1476] Obituary, p. 17.
[1477] Huw Bowen, 'Copperopolis: Swansea's Heyday, Decline and Regeneration' *History of Capitalism Series*, Legatum Institute (2016), https://lif.blob.core.windows.net>docs>default-source [accessed 24 September 2019], pp. 8-9.
[1478] RBA, SUC / LAC / 69 / E7, K. J. Hilton, *Letter to Robin Huws Jones* (July 1963).
[1479] UCS, *Forty-Third Report* (1962-63), p. 30.
[1480] UCS, *Forty-Third Report*, p. 30. For further research on the Lower Swansea Valley Project there is a comprehensive archive at the Richard Burton Archives, Swansea University, reference no: GB 217 LAC /69 (1936-1967).
[1481] Obituary, (2019, August), Tom Margerison, *Telegraph.* Along with his colleague Percy Cudlipp, Margerison established Britain's first weekly science journal, the *New Scientist* in 1956. Margerison was the journal's first editor.
[1482] Williams, p. 966.

forestation of the area.[1483] There was support for the Swansea project from Professor Stanley Beaver and the Geography department of the University College of North Staffordshire who visited the project in 1962.[1484] Beaver and his department had experience of environmental reclamation as they had been involved in reclaiming industrial land in the Black Country and Staffordshire.[1485] However, these visits were arranged not by the scientists themselves, but by K. J. Hilton who as director of the project facilitated academic connections with local authority officials. In addition to the academic and local authority collaboration, agencies such as the Forestry Commission were invited to meetings facilitated by Hilton using newly available space at the institution such as the conference room in the new chemistry building.[1486]

The Lower Swansea Valley Project revealed how the internal departmental connections that were established within the federal system of the University of Wales were pertinent to the success of large collaborative projects. The expertise from the Geology department of the University College of Cardiff was essential to the early part of the project, as the department made available geophysical equipment for the geological survey which took place in 1962.[1487] In addition to the loan of specialised equipment, Professor J.G.C. Anderson, head of the Geology department, gave permission for members of his staff to travel to Swansea and operate the equipment and interpret the results.[1488] Furthermore, support and expertise concerning heavy-metal-tolerant grass strains to be used for re-planting on the site were given by A. D. Bradshaw from the University College of Bangor.[1489] By the time the project was completed and its findings published in 1967 the project itself became an established area of research for students from other institutions studying courses in conservation.[1490]

[1483] RBA, reference no: SUC / LAC / 69 / E3, K. J. Hilton, *Letter to Mr. Casson, Divisional Planning Officer, Lancashire County Council* (November 1961).
[1484] RBA, reference no: SUC / LAC / 69 / E3, K. J. Hilton, *Letter to D. W. Riley, County and Planning Officer, Staffordshire* (September 1962).
[1485] RBA / SUC / LAC / 69 / E3.
[1486] RBA, reference no: SUC / LAC / 69 / E3, K. J. Hilton, *Letter to Park Superintendent* (1 June 1962).
[1487] W. F. G. Cardy, 'Report (4) on the Geology of the Lower Swansea Valley Project Area' in *The Lower Swansea Valley Project* ed by K. J. Hilton (London: Longmans, Green and Co Ltd, 1967), pp. 3 and 26.
[1488] Cardy, p. 26.
[1489] Hilton, p. 110. Expert help on grass strains also came from Professor Beaver, University of North Staffordshire, D. A. Wilkins, University of Birmingham, and the Camborne School of Metalliferous Mining.
[1490] RBA, SUC / LAC / 69 / E10B, Professor Street, *Letter to Dr Newbould, Department of Botany, UCL* (1961).

Conclusion

As the temporary science buildings built during the first decade of the University College of Swansea's history were a symbol that the institution was firmly established, then the skyscraper towers built on campus in the 1960s symbolised the extent of the science faculty's modernization. Such expansive developments at the science faculty were undertaken as a crisis of the future of the University of Wales's federal system focused the attentions of the constituent colleges and the university. This was of particular relevance for the Swansea institution as the specialised skills of its principal, John Horace Parry played a key role in guiding the university along a steady path as the university grappled with historical concerns of the federal structure and the complex issue of institutional identity. While the conflict between the calls for college independence and the jurisdiction of the university created long-term divisions, it took concessions of curriculum independence to halt the break-up of the university's federal system. Furthermore, the issue of collegiate independence had a contradictory effect on college expansion by both encouraging departmental expansion and restricting curriculum developments within the individual colleges. The internal crisis did not halt building developments within the constituent colleges, in fact the size of the expansion dwarfed the previous post-war developments.

At the heart of this expansion were two main themes that dominated the political will to ensure that there was a push towards university expansion on a national level: First, public concerns over a national economic decline, second, strengthening the connections between academic science and industry. Political ambitions shaped government education policy, and through departmental re-organisation gave direct power to the Minister of Education. This allowed for government education policy to be implemented more directly, thereby influencing the change of direction of academic scientific research towards industry. By specifying the importance of strong connections between modernisation and academic and industrial collaboration, the government ensured an increase in state financial support for university expansion. The University College of Swansea was proactive in using state aid to successfully implement ambitious plans for the Singleton campus with the science faculty at the core of the development.

The substantial increase in state funding enabled the Swansea institution to finally replace the original 1924 'temporary' science blocks for permanent modern buildings. While the new science blocks were equipped to accommodate teaching and researching for increasing numbers of students, the extension of the facilities also encouraged inter-disciplinary connections across departmental boundaries. Equally important, the structure of the Welsh science degree encouraged fluidity within the disciplines and challenged the widely held assumption that courses were always established along traditional lines in British universities. The expansion of facilities and courses created opportunities for sub-disciplines to be established and developed into departments. Thereby, by 1970, these type of internal curriculum developments generated within the science faculty extended departmental research capabilities and enabled the science departments to reach their ‘critical mass’ of development. In addition, the scientific communities at the science faculty had sustained and increased regional, national, and international research partnerships with academic, research agencies and industry. The success of such partnerships are highlighted by the collaborative research undertaken by the science faculty, which enabled the wider community of Swansea to benefit greatly from the environmental projects that addressed regional marine pollution and industrial regeneration.

Conclusion

The establishment of the University College of Swansea in 1920 was the consequence of a 'perfect storm' of political desires, industrial needs, and an awareness of a neglect of scientific education in Wales. These factors were re-affirmed by the pressures and needs of a world war. Indeed, it was the outbreak of World War I and the subsequent years of conflict that focused political, industrial, and educational conversations on the inadequacies of scientific education across Britain and highlighted the vital role of university scientific research. Yet, these were not new debates. There was a direct link from these twentieth century conversations to early nineteenth-century concerns regarding scientific and technical education which continued to resurface throughout the century across different spheres of influence. The desire for university reform was interrelated with a complex set of issues linked to economic growth accompanied by national feelings of decline. However, only a few individuals had the vision to connect these issues together as the way forward to modernize British commerce and industry. It was the campaigning of Lyon Playfair, Thomas Henry Huxley and Bernhard Samuelson and others who directed the debates towards the pivotal argument of tertiary curriculum reform. In addition, the involvement of influential politicians such as Lord Henry Brougham and Lord Richard Haldane ensured that the issue remained politicized.

In Wales, the scientific curriculum issue was highlighted in the observations and comments in the report of the 1916 Royal Commission on Welsh university education, which stated the inadequacies of scientific education in Wales. In addition, the curriculum debate in Wales was directly linked to the nineteenth century discourse on the direction of Welsh education provision and the historical development of its colleges and university. A determination to deliver an accessible national university system in Wales ensured that its bureaucracy was built on a federal structure. The support of a central system ensured the survival of the three small constituent colleges during their early years, and which allowed each college to establish science disciplines on their curriculum. Yet, the politics of Welsh national identity shaped the University of Wales' focus on the institution's educational direction on the humanities rather than the sciences. This educational bias added to the university's increasing culture of conformity and uniformity and guided the three constituent colleges against the flexibility of the federal system in relation to their curriculum. This is apparent by the failure of all the colleges to establish teaching and research programmes to resolve issues connected with the vital industries of Wales. The decision by the University of Wales to encompass a fourth constituent college at Swansea was an acknowledgement of the need for a higher education institution which would deliver scientific teaching and research requirements of the industrial region of South Wales.

Community

While there was a recognised lack of success by the colleges of the University of Wales in connecting with heavy industry, the concept of a 'community of interests' relating to the development of a scientific department was visible at the Welsh colleges during their early histories. The collaboration between the department of chemistry at Bangor and the local farming community created a pioneering research programme that would be the foundation of a department of agriculture. A similar ethos of collaboration between academia, industry and civic authorities initiated an area of research at the zoology department at Aberystwyth College. These partnerships were established prior to the establishment of the University of Wales and the creation of the institution's federal system. The fact that by the turn of the twentieth century the three constituent colleges failed to establish strong links with the mining and heavy industries of Wales did not mean that educational and industrial connections did not exist in the region. The network that had grown between the Swansea Technical College and the industrialists of the area became the bedrock of future industrial relationships with the newly established University College of Swansea.

The financial assistance generated by industrial firms and mining companies was essential to the development of the institution during its early years. However, the initial absence of a permanent site and the predicament of sharing the teaching and research facilities of the Technical College put immense pressure on the staff members of the science departments. Moreover, the move to the permanent site at Singleton Abbey created further complications as heads of departments and staff had to establish their departments anew. Yet, it was the development of a sense of community, both on an internal departmental level and in the wider institutional space that enabled the scientific and technical staff to successfully establish a functioning science faculty. The evolution of community within the different disciplines was advanced by not only having to co-operate in adverse conditions, but by the informality that is created amongst employees who have had previous professional connections. An ethos of co-operation and community was led from the top, due to the flexible managerial style of the institution's first principal who was supported by a team of experienced, enthusiastic and youthful heads of department.

The correspondence of the first and long-serving college registrar, Drew, affirms the emergence of small cohesive communities within the individual science departments. This archive source spans the first four decades of the institution and the communication reveals a determination to deliver a high level of teaching and research within the five science departments. This aspiration remained the nucleus of departmental philosophy during the institution's first four decades that witnessed the expansion of all the science departments and increasing student numbers. The teaching and research achievements of senior scientific staff were enabled by the input from junior scientists, laboratory technicians and administrators who were essential to the departmental community. However, it must be noted that there was a skew to these communities in terms of gender balance both with staff and students. Apart from the Biology department where since its foundation there had been a female head of department and the female to male ratio was more balanced, the science communities were a male domain.

Archival evidence reveals the presence of women as students and staff in the other science disciplines, but their footprint is small in the departmental histories. There were exceptions to this anonymity of female scientists at the University College of Swansea and they are briefly mentioned in the Dykes historical account of the institution. Yet, it is apparent that female students studied in an environment where their seniors and peers were predominately male. Furthermore, undertaking field and industrial research was problematic as gender inequality was prevalent in the industrial and research communities that had connections with the institution. It is apparent that the University of Wales favoured well compared to other universities in another aspect of the sociological make-up of its student population, which was in the number of its student population who had working-class origins. Furthermore, the science faculty took initiates to attract potential students from the industrial hinterland of Swansea with the establishment of series of science lectures in those areas, and thereby, affirmed its connections with the industrial communities of the region.

Once established the ethos of the wider academic community of the science faculty was defined by a collaborative approach between the heads of departments to campaign for better work conditions and higher wages for the scientific and technical staff of their departmental communities. Unfortunately, due to financial restraints in the inter-war years there was limited success in establishing promotional opportunities for junior scientific staff, as well as achieving pay upgrades for skilled technical staff. These developments were essential to encouraging talented individuals to continue their careers at the Swansea institution, and the consequences of these failures was the departure of key members of staff. Drawn by career opportunities in academic, industrial and research agencies their departure had the potential to compromise departmental unity. However, the distinctive qualities of inclusivity within the departments encouraged successful integration of new members of staff. Yet, while the characteristics of the concept of community were essential to the development of collectiveness within the individual science departments, it was achieved within a framework of a hierarchical system. As the departmental heads were at the apex of the departmental hierarchy their personalities shaped the departmental ethos which was reinforced by the longevity of their appointments. A lengthy term of employment was a characteristic of nearly all the senior staff at the University College of Swansea who were appointed at the institution's foundation in 1920. These scientists defined and established their careers at the university college and additionally, a high ratio of their successors would spend a considerable part of their careers at the institution as well. In later decades, a few individuals would start their careers as students of the science faculty and remain at the institution for the rest of their working life. These long-term appointments at a senior level encouraged a paternalistic attitude to the rest of the department. Therefore, when the pressures of limited teaching and research space and inadequate staff numbers became acute, long-serving heads of departments were very vocal in asserting their departmental authority on behalf of their departmental communities.

One consequence of the longevity of these senior appointments ensured that the connections they made with industry and other agencies were well established and remained constant. The academic and industrial links created their own communities that focused on generating research projects that addressed the concerns of industry. The success of this collaboration is not just measured by the research undertaken for industry but by the creation of ‘work experience’ for students and lecturers in industrial plants post-World War II. An equally important point is that it was also staff continuity that positioned the institution in a positive place to deal with the major disruption of World War II. Senior staff members enabled teaching and research to continue despite staff enlistment and the sequestration of a large part of the science blocks for government war research, and the expertise of long-serving technicians addressed the problems of equipment shortage and enforced rationing. Furthermore, loyalty to the departmental community is shown by the actions of departmental heads who were supportive of individual staff members who were under undue pressure from the war machine. The deprivations of academic life during the war consolidated community ties within the science faculty as the use of many campus facilities were centralised and shared.

While scientific communities were established within the science faculty of the University College of Swansea, the institution benefited from being part of the larger science community of the University of Wales. This thesis has concluded that an earlier negative consequence of the university’s federal system had been to limit areas of scientific teaching and research, but during the first part of the twentieth century scientific departments had expanded at the three sister colleges. Thereby, after its foundation the fourth constituent college at Swansea joined the science community within the University of Wales, which offered mutual support to their colleagues in the four colleges. Such aid was inclusive of academic, technical, and scientific expertise. Inter-collegiate collaboration within the University of Wales expanded during the fifties and sixties. This was a direct consequence of the post-war expansion of the university institution in Britain and especially the academic science disciplines.

The establishment of collaborative research projects were not only directed by the needs of local industries, but by the specialisation of senior scientists in the departments. In certain instances, the research interest of junior staff members shaped the direction of a research project. The support of such research by the departmental head in acquiring appropriate funding, facility space and specialised equipment and materials was essential to the viability and development of the enterprise. Accordingly, these investigations developed into research communities within the departmental community. Furthermore, certain specialised departmental investigations evolved into external permanent scientific communities, notably the establishment of the British Iron and Steel Research Association laboratories at Sketty Hall in Singleton Park. Nonetheless, the development and expansion of the science faculty did not compromise its community ethos. Indeed, it enabled its scientists and students to be involved in the increasing number of large-scale collaborative research programmes and their communities that were established during and post-World War II.

Infrastructure

The increasing complexity of scientific academic communities during the first half of the twentieth century required infrastructure that provided a range of specialised laboratories and facilities. Yet, the conclusion by William Whyte that the buildings of many civic universities were historically inadequate in relation to their function as centres of teaching and research is an appropriate deduction to make regarding the early accommodation of the University College at Swansea.[1491] The institution's initial infrastructure was 'borrowed' insofar that it was shared with the Swansea Technical College. Yet, despite the move to the permanent site of Singleton Abbey and the building of the 'temporary' science huts, the institution was deficient in terms of teaching and research space for more than three decades from the institution's foundation. However, the siting of the university college at Singleton Abbey was fortuitous for the future development of a modern university campus, due to the availability of land around the Abbey building. In addition, the institution's wider environment of parkland and beach frontage was, and still is, a premium to attract prospective students.

The college authorities and departmental heads were aware that the creation of permanent buildings was necessary for the successful development of the science faculty for two critical reasons: First, the effective deliverance of a range of applied and pure science courses, second, the opportunity for departmental growth including the expansion of research. Yet, the provision of departmental space for the science departments had been a complicated process that left college authorities struggling to

[1491] William Whyte, *Redbrick A Social and Architectural History of Britain's Civic Universities* (Oxford: Oxford University Press, 2015).

balance the desires and needs of the departmental heads and the limited budget of the college. The construction of the science blocks or pavilions was considered a temporary solution to departmental space. However, due to the continuing financial restrictions they would provide a permanent residence to the departments of metallurgy, physics and chemistry for the next four decades. The building's facilities and laboratories were a symbol of the collaborative ethos of the science faculty as the input from science and technical staff in the design and fitting of the laboratories was significant. The buildings provided the appropriate space to enable the teaching and research of the three disciplines as well as offering facilities for post-graduate studies. The latter was essential as underpinning the institution's academic profile was the quality of its research, and therefore it was imperative to broaden the areas of scientific research across the science disciplines to consolidate the institution's academic reputation regionally, nationally and internationally.

The need to establish permanent infrastructure for the biology and geology departments became acute within the first decade of the institution's history, and their predicament revealed the unsuitability of the Abbey building as a scientific teaching resource. While the interior of the building had been renovated and redesigned from serving as a private residence, the redevelopment failed to provide appropriate facilities for an educational institution. The modernisation had been hastily executed, with the consequence that there were regular re-assessments for the use of the limited space causing disruption and stress for the staff and students of the geology and biology in the Abbey building. The disorganisation caused by the re-evaluations of departmental space were compounded later in the decade by departmental growth and curriculum expansion to accommodate the subdiscipline of zoology and increasing courses in geography. Furthermore, departmental success in attracting a steady increase of student numbers and the rise in the number of students who wished to study geography fulltime exacerbated the issues of infrastructure inadequacies. However, it is clear from the university college archives that individual staff members were proactive in establishing connections with outside agencies who provided additional research space to supplement the inadequacies of the college.

Unfortunately, the consequences of external forces notably the adverse financial climate of the 1930s and the outbreak of World War II had an adverse effect on university funding nationally. These circumstances had ramifications for the development of a permanent infrastructure for the science faculty at the University College, Swansea. Plans for future construction at the institution were shelved during the war-years and financial restrictions continued in the early post-war years. Yet, it is apparent that senior members of staff were motivated to plan for the future of their departments and ensured that these aspirations were communicated regularly to the different levels of the college administration. Some of these aims had their roots in the institution's first decade, one of which was a plan to centralise the natural science disciplines into one specifically designed building. As a result of taking decades to realise the plans for the Natural Sciences building, its teaching and research facilities would only benefit post-World War II staff and students. The construction of the first stage of the Natural Science Building in 1956 was unique in the post-war modernisation of the campus as it was the only science building included in this stage of infrastructure development. Furthermore, this was first structure to be built on the west side of the site which expanded the size of the campus and created new opportunities for future development.

Yet, the urgent needs of the science disciplines who were still operating in their 'temporary' huts were relegated to deliver the plans to create a cohesive and American style college campus. The building of student accommodation and facilities had a modernising impact on the site, but it was frustrating for those scientists and their teams working in the institution's earlier infrastructure who had to yet again undergo 'temporary measures'. By the post-war period the temporary buildings' operational life was undermined due to decades of constant use which was compounded by the considerable disrepair left by the Woolwich department's secret war work. The decision to delay rehousing a significant part of the science faculty was contrary to the aims of post-war government policy on university expansion that was intended to create a substantial increase in places for future science and technology students. Yet, this delay was addressed in the 1960s with the completion of buildings specifically designed to accommodate the departments of chemistry, physics, and the applied sciences, and the finalisation of the second section of the Natural Sciences building. The infrastructure of the science faculty physically dominated the campus during this period and their facilities were a contradistinction to those offered by the 'temporary' huts.

Connections

For a scientific community to function in an academic space the appropriate infrastructure is essential, but for that community to thrive it requires a network of external professional and associate connections. From the onset of their arrival at the science faculty the appointed individual scientists had already formed their own networks of professional links with academia and industry. Moreover, some of these early appointments were directly interrelated to their previous professional connections. This was not unusual as the initial professional relationships made by many scientists were formed at the study stage of a career and during earlier career appointments. Moreover, such connections were placed within the national framework of the institution of the university which during the first half of the twentieth century was extended to include universities across the British Empire. Indeed, individual scientists were aware that the relationships established with commerce, research agencies and industry were just as relevant as the traditional links within academia.

The development of connections with industry was paramount due to the institution's remit to address the needs of industry. The challenge of creating and maintaining industrial contacts was accomplished by targeted measures initiated by the institution which included the establishment of advisory committees connected to different industries. A more informal approach but just as effective was the senior and junior academic staff's involvement in regional branches of national industrial societies. Arranging opportunities to promote a two-way dialogue discouraged industrial mistrust of academia which had hampered earlier relationships with the University of Wales. At the same time, the involvement of local industrials with the activities of student scientific societies offered opportunities for students to make their own connections with industry. The increase of scientific societies at the institution ensured that these chances were also extended to students of societies of other scientific disciplines to connect with areas of commerce that they were unfamiliar with. In addition, the research experience of the science student was enhanced by associations with other institutions, notably the Museum of Wales whose staff expertise and collections were useful to the Biology and Geology departments.

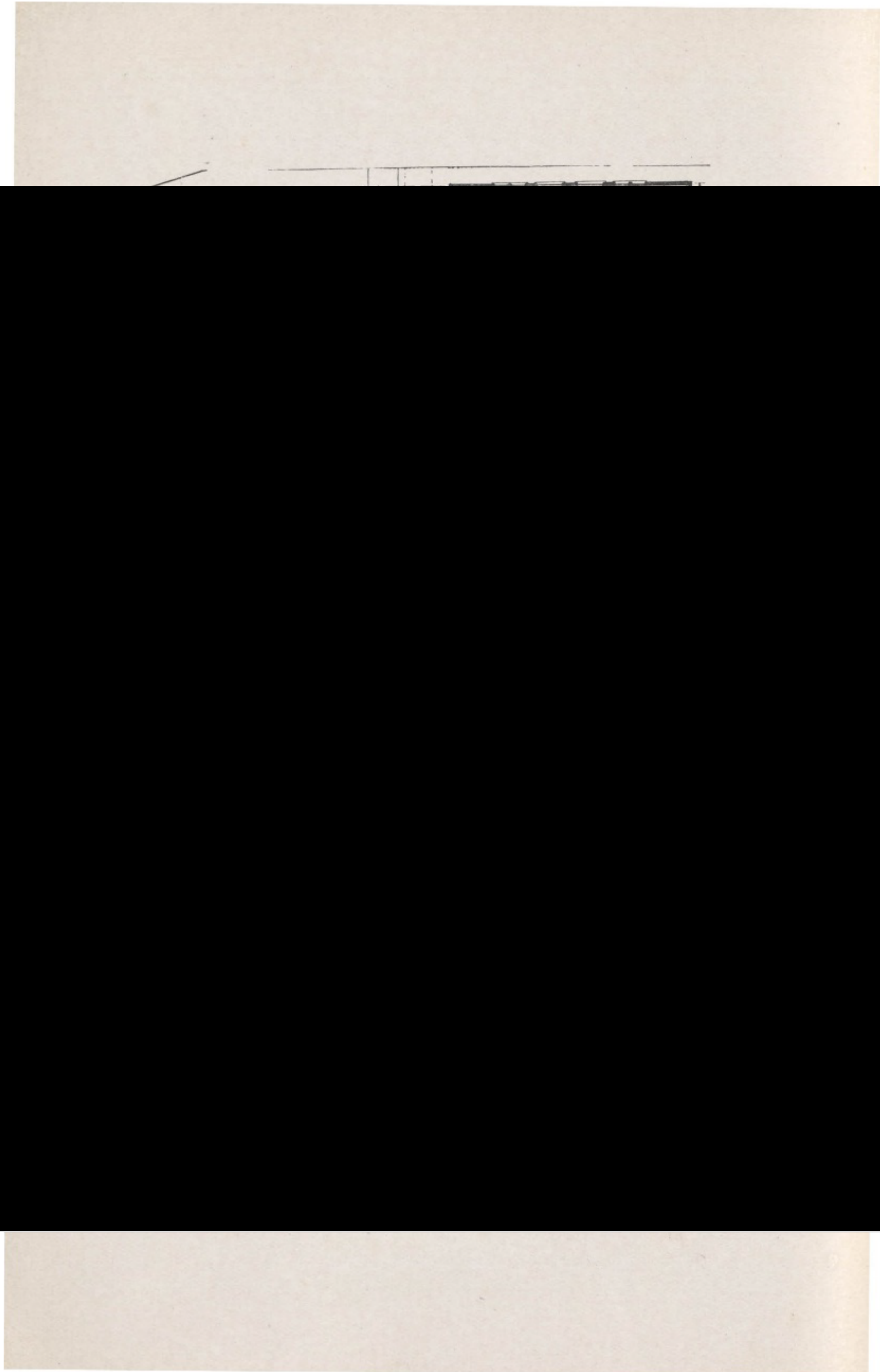
Additional opportunities to interact with other individuals from a specific scientific discipline were made possible by conferences and symposiums. The different science departments at the Swansea institution were proactive in the organisation and hosting of such events. However, due to limited facilities during the early stage of the campus development these functions were few, but with the modernisation and expansion of the science faculty's infrastructure the number of these events increased. In addition, the areas of discussion at symposiums and conferences mirrored the increasing specialisation of research, and consequently the specific expertise of scientists at the Swansea institution were in demand for regional, national, and international conferences. In the same way as conferences and other scientific gatherings created possibilities for senior scientists to promote their research, so did overseas lecture tours. Also, international connections were a valuable resource in the arrangement and success of the abovementioned tours. In these ways the science faculty at the University College of Swansea connected with the transnational community of academia and scientific research. Furthermore, increasing financial support from research grants as well as travel grants directed through the University Grants Committee enabled greater numbers of its students to be part of international scientific events and projects.

Re-establishing international scientific connections was of immense importance to the reconstruction and modernisation of a post-war Europe. As the research conducted by universities and the graduation of greater numbers of future specialist scientists and technologists were an essential part of infrastructure and commercial recovery. Moreover, while reconstruction and the creation and the proliferation of new industries offered many opportunities for the science community, the spectre of the cold war also offered opportunities in the expanding industrial/military complexes. The transnational connections made by staff from the different science departments from the University College of Swansea ensured that they and their students were involved in collaborative international projects as varied as CERN, IERE and the Austerdalsbreen Expeditions. Their contribution to these high-profile projects and the connections that were established with other academic institutions and research agencies were an acknowledgement of the academic profile of the science faculty and ensured its national and international scientific reputation.

By the 1960s the scientific communities of the science faculty were successful in engaging with multiple national and international research projects, as well as epistemic scientific communities, due to departmental expansion and the creation of modern infrastructure. Equally important to the institution was its status within the locality, and this was cultivated by the science faculty's connections with the wider community of the town of Swansea. The decade of the sixties witnessed historical connections with industry broadening into new research investigations into the environmental health of the region. The institution's engagement with the industrial reclamation scheme, the Lower Swansea Valley Project firmly established its scientific credentials with the local population due to the high-profile character of the project. Equally important the establishment of other regional environmental projects that were connected to marine research played a seminal role in laying the foundations of a future new science department of oceanography.

The establishment of new science departments was a post-war feature of the growth of the science faculty, with the incorporation of the departments of geography in 1954, zoology in 1956, and the establishment of genetics in 1966. Furthermore, oceanography was not the only sub-discipline that was being developed into a department of its own, plans for a department of biochemistry was also in the development stage during this period. At the end of the 1960s, academic expectations of continual departmental growth reflected a confidence in the academic status of the science faculty, which unfortunately was not realised in the following decades. However, by 1970, the ongoing departmental expansions and diversification of scientific research epitomized the 50 years of progress made by repeated communities of the science faculty from its modest beginnings in 1920.

Appendix A: Plan of Metallurgical Department, University College of Swansea, circa 1922.



[redacted]

Appendix B(i): University College of Swansea, Financial Endowments and Private gifts received from Local Industries between 1918-1920 (for general purposes)

Date	Industry	Amount (£ s p)
09/11/1918	W. T. Farr Esq.	326.0.0
20/08/1920	The S. Wales Basic Slag Co.	262.10.0
02/09/1920	The S. Wales Siemens Steel Association	2,500.0.0
29/10/1920	The Aberdulais Tinplate Co.	30.0.0
29/10/1920	The Aberavon Tinplate Co.	20.0.0
29/10/1920	The Ashburnham Tinplate Co.	20.0.0
29/10/1920	The Beaufort Works Limited	125.0.0
29/10/1920	The Bryn Works	20.0.0
29/10/1920	Messrs. R. B. Byass and Co.	200.0.0
29/10/1920	The Clayton Tinplate Co.	35.0.0
29/10/1920	Messrs. Cleeves Anthracite Collieries Limited	500.0.0
29/10/1920	The Dafen Tinplate Co.	30.0.0
29/10/1920	The Dulais Tinplate Co.	20.0.0
29/10/1920	The Dynevor Tinplate Co.	15.0.0
29/10/1920	The Dyffryn Works Ltd.	60.0.0
29/10/1920	The Eagle Tinplate Co.	35.0.0
29/10/1920	The Fairwood Tinplate Co.	20.0.0
29/10/1920	The Ferry Tinplate Co.	20.0.0
29/10/1920	The Ffrwdyllt Co.	20.0.0
29/10/1920	Messrs. W. Gilbertson & Co.	500.0.0
29/10/1920	The Glynbeudy Tinplate Co.	20.0.0
29/10/1920	The Glanrhyd Tinplate Co.	40.0.0
29/10/1920	The Glynhir Tinplate Co.	25.0.0
29/10/1920	The Grovesend Steel & Tinplate Co.	160.0.0
29/10/1920	The Grynos Tinplate Co.	15.0.0
29/10/1920	The Grynos Tinplate Co.	35.0.0
29/10/1920	The Molyn Tinplate Co.	55.0.0
29/10/1920	The Mardy Tinplate Co.	30.0.0
29/10/1920	The Morlais Tinplate Co.	50.0.0
29/10/1920	The Morriston Tinplate Co.	65.0.0
29/10/1920	The Old Castle Iron and Tinplate Co.	100.0.0
29/10/1920	The Old Lodge Tinplate Co.	40.0.0
29/10/1920	Messrs. John Player & Sons.	20.0.0
29/10/1920	The Pemberton Tinplate Co.	20.0.0
29/10/1920	The Resolven Tinplate Co.	20.0.0
29/10/1920	The St. David’s Tinplate Co.	55.0.0

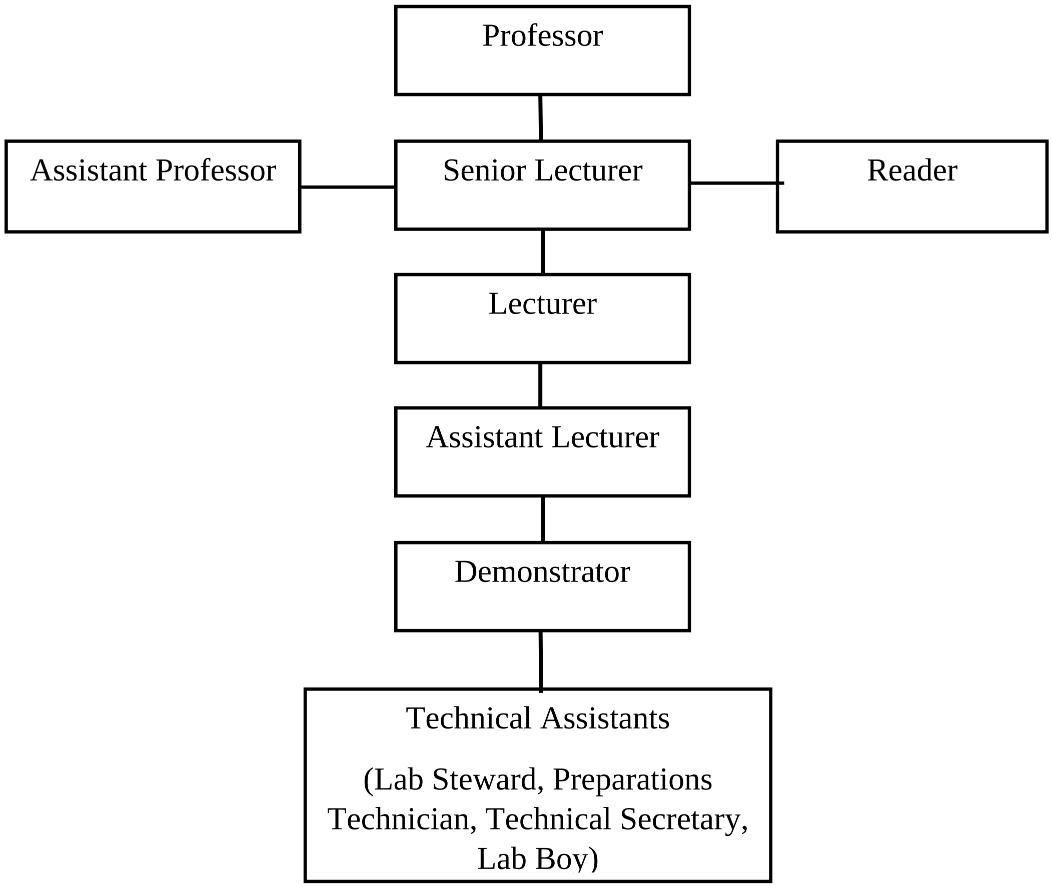
29/10/1920	The Teilo Tinplate Co.	60.0.0
29/10/1920	Messrs. J. S. Tregonning & Co.	25.0.0
29/10/1920	The Upper Forest & Worcester Tinplate Co.	90.0.0
29/10/1920	The Villiers Tinplate Co.	35.0.0
29/10/1920	The Wern Tinplate Co.	20.0.0
13/11/1920	The Neath Steel Sheet and Galvanising Co.	50.0.0
19/11/1920	The Park Tinplate Co.	30.0.0
04/12/1920	Messrs. Webb, Shakespeare & Williams	20.0.0
	Total	6,638.16.0

N.B. The capital value of W. T. Farr Esq. endowment is £10.000
With the exception of the income from the donation made by W. T. Farr to the Endowment Fund, all the above are annual subscriptions for at least 5 years.
N.B. £ s d spoken as ‘pounds, shillings and pence’ is the popular name for the British pre-decimal currency. Under this system there were 4 farthings = 1 pence, 12 (pennies) = 1 shilling, and 20 shillings or 240 pence = 1 pound. The decimal currency came into use in 1971.

Appendix B(ii): University College of Swansea, Capital benefactions received in 1920 (for sites, buildings, and permanent equipment)

Date	**Industry**	**Amount (£ s p)**
19/07/1920	The Beaufort Works Ltd.	500.0.0
02/09/1920	Mr. William Morgan	500.0.0
02/09/1920	Mr. William I. Williams	500.0.0
13/09/1920	Messrs. Sulzer Bros.	200.0.0
02/10/1920	The Old Castle Iron and Tinplate Co.	500.0.0
29/10/1920	The Clayton Tinplate Co.	250.0.0
29/10/1920	The Aberdulais Tinplate Co.	250.0.0
29/10/1920	The Glynbeudy Tinplate Co.	100.0.
29/10/1920	The Glynhir Tinplate Co.	100.0.0
29/10/1920	The Grovesend Steel and Tinplate Co.	500.0.0
29/10/1920	The Morlais Tinplate Co.	250.0.0
29/10/1920	The Park Tinplate Co.	2,100.0.0
13/11/1920	The Neath Steel Sheet & Galvanizing Co.	100.0.0
19/11/1920	The Baglan Bay Tinplate Co.	150.0.0
19/11/1920	The Yniscedwyn Co.	100.0.0
25/11/1920	The Melyn Tinplate Co.	2,600.0.0
	Total	4,700.0.0

Appendix C: University College of Swansea Organogram, circa 1968



Dramatis Personae

Ackland, Francis Dyke (1874-1939) Liberal politician, Under-Secretary of State for Foreign Affairs.

Ackland was educated at Rugby School and went on to Balliol College, Oxford.

Airy, Sir George Biddell (1801-1892) Mathematician and astronomer.

Airy was educated at an elementary school in Hereford and then Colchester Royal Grammar school. He entered Trinity College, Cambridge in 1819 as a 'sizar' which meant that he paid a reduced fee but had to make up the reduction by working as a servant. Airy was elected scholar of Trinity College in 1824. In 1836 he was made a Fellow of the Royal Society.

Allen, Norman Percy (1903-1972) Metallurgist.

Allen was sent to be educated at Burton-on-Trent Boys' Grammar School. He then attended Sheffield University where he was awarded an honours degree in metallurgy.

Anderson, John Graham Comrie (1910-2012) Geologist and university professor.

Anderson attended Glasgow Academy and then went to Glasgow University in 1928 to study geology. He graduated with a first-class Honours in Geology and was awarded an MA in 1932. Anderson stayed at Glasgow University and was awarded a PhD for his thesis on 'Contributions to the Caledonian igneous geology of the South West Highlands'.

Appleton, Edward Victor (1892-1965) Physicist and university professor.

Appleton was educated at the Hanson Grammar School in Bradford. In 1911 at the age of 18 years he was awarded a scholarship to attend ST. John's College, Cambridge where he received a first-class Honours in natural science with physics in 1913. Appleton was made a Fellow of the Royal Society in 1927 and was awarded the Nobel Prize in 1947.

Arnold, Matthew (1822-1888) Poet, cultural critic and Her Majesty's Inspector of Schools.

Arnold was tutored by his uncle Reverend John Buckland in the village of Laleham and in 1836 went to Winchester College. A year later he returned to the family residence at Rugby School where his father was headmaster. Arnold enrolled in the school at fifth form and was tutored by his father at sixth form level. In 1841 Arnold won an open scholarship to Balliol College, Oxford where he graduated with a second-class Honours in Literae Humaniores. In 1845 he was elected a fellow of Oriel College, Oxford.

Atlee, Clement Richard (1883-1967) British politician and prime minister.

Atlee was sent to Northaw School, a prep school for boys near Pluckley, Kent. He then went to Haileybury College and later to University College, Oxford. In 1904 Atlee graduated with a BA second-class Honours in modern history. Atlee trained as a barrister at the Inner Temple and was called to the bar in 1906.

Babbage, Charles (1791-1871) Polymath, mathematician, philosopher, inventor and mechanical engineer.

Due to ill health as a child, Babbage was intermittently home tutored and attended the County school in Alphington near Exeter and King Edward VI Grammar school in Totnes, South Devon and Holmwod Academy, Middlesex. In 1810 Babbage attended Trinity College, Cambridge and in 1812 transferred to Peterhouse, Cambridge where he graduated in 1814.

Bacon, Frederick (1880-1943) Engineer and university professor.

Bacon was educated under a private tutor Dr R. Lachlan and started work in the marine engine works of Messrs. Plenty and Son, Newbury. In 1899 he entered Trinity College, Cambridge and studied under Sir Alfred Ewing and obtained a first-class Honours in the Mechanical Sciences Tripos.

Balchin, William (1916-2007) Geographer and university professor.

Balchin went to school in Aldershot and at the age of 16 years took a Higher Schools Certificate and a County Major examination for a university grant. He was refused due to his young age, but he later achieved a state award and county grant to study geography at Cambridge. Balchin was later awarded a PhD for his mapping of erosion surfaces on Exmoor.

Balfour, A. J., 1st Earl of Balfour (1848-1930) Conservative Statesman, Prime Minister.

Balfour was educated at Grange Preparatory School at Hoddesdon, Hertfordshire from 1859-1861. He then went on to Eton College between 1861-1866. Balfour went to University of Cambridge and read moral sciences at Trinity College in 1866 and graduated in 1869 with a second-class Honours.

Beveridge, William Ian Beardmore (1908-2006) Animal pathologist and university professor.

Beveridge was born at Junee, Australia where he attended the local primary school. Due to his academic promise he was sent as a boarder to Cranbrook School, Sydney. In 1926 he went to the University of Sydney to study veterinary science.

Beynon, John H. (1923-2015) Welsh physicist and chemist.

Attended University College of Swansea in the early 1940s and graduated with an Honours degree in Physics.

Beynon, William John Granville (1914-1996) Physicist.

Beynon's secondary school education was at the Gowerton Grammar School, Swansea. He later entered the University College of Swansea where he studied Physics.

Bliss, Daniel (1871-1939) Christian missionary and founder of the American University of Beirut.

Bliss went to school in Georgia, Vermont, U.S.A. He graduated from Kingsville Academy in 1848 and went on to Amhurst College. Bliss graduated in 1852 and entered Andover Theological Seminary and was ordained in 1855.

Bohr, Niels (1885-1962) Danish Physicist.

At the age of 7 years Bohr went to the Gammelholm Latin School in Copenhagen, Denmark. Bohr then enrolled at Copenhagen University in 1903 and majored in physics. In 1909 he achieved an MA in mathematics which he extended to a DPhil. Bohr achieved his doctorate in 1909.

Bowen, Edward George (1911-1991) Physicist and university professor.

Bowen attended a primary school in Sketty, Swansea and in 1922 won a scholarship to the Municipal Secondary School in central Swansea. Later he was awarded a scholarship to enter the University College of Swansea. In 1930 he graduated with a first-class Honours in Physics and remained at the institution to undertake post-graduate research under the direction of Dr W. Morris Jones and Professor J. V. Evans. Bowen was awarded an MSc in 1931 and went on to take a PhD at the Physics Department of King's College under the direction of Professor E. V. Appleton.

Bradshaw, Anthony David (1926-2008) Evolutionary ecologist and university professor.

Bradshaw was educated at St Pauls School, Hammersmith, London and went on to read Botany at Jesus College, Cambridge. In 1947 he moved to Wales to undertake postgraduate studies at the University College of Aberystwyth.

Brougham, Lord Henry (1778-1868) Statesman, Lord Chancellor.

Brougham was educated at Royal High school, Edinburgh and went on to the University of Edinburgh where he studied natural science, mathematics and law. He was elected a fellow of the college and admitted to the Faculty of Advocates in 1800. Brougham entered Lincoln's Inn in 1803.

Buckland, William (1784-1856) Geologist and palaeontologist.

Buckland was educated at Blundell's school, Tiverton, Devon and then Winchester College. He won a scholarship to Corpus Christi College, Oxford. After graduating with BA and a MA he was made a fellow of the College in 1809 and was ordained as a priest.

Calder, Peter Ritchie (1906-1982) Socialist author and journalist.

Calder was educated at Forfar Academy, Forfar, Scotland. Trained as a journalist in Dundee.

Carpenter, Henry Cort Harold (1875-1940) Metallurgist and university professor.

Carpenter went to Eastbourne College in 1892 a year later he was awarded the Science Postmastership at Merton College, Oxford University where he was awarded a first-class Honours in 1896. He then went to the University of Leipzig and studied German for two years. Carpenter had the distinction of being the first foreigner to be awarded the PhD 'summa cum laude' in any German university.

Cavendish, William, 7th Duke of Devonshire (1808-1891) Landowner, benefactor, politician and M.P.

Cavendish was educated at Eton and then entered Trinity College.

Chapman, Pincher (1914-2014) Author, journalist and historian.

Chapman went to 13 schools before his family settled in Darlington. At the age of 10 years he won a scholarship to Darlington Grammar School. He later entered Kings College London where he studied zoology and biology.

Coates, Joseph Edward (1883-1973) Chemist and university professor.

There is no mention of Coates early education, but he gained his first degree at the University College of North Wales, Bangor. He later undertook further research in Germany at the Technische Hochschule, Karlsruhė where he collaborated with Professor Haber.

Crossland, Anthony (1918-1977) Labour politician and author.

Crossland was brought up in North London and attended local schools including Highgate School. He then entered Trinity College, Oxford where he obtained a second-class Honours in Classical Moderations in Greek and Latin Literature. After the end of

World War II Crossland returned to Oxford where after studying for 12 months he obtained a first-class Honours degree in Philosophy, Politics and Economics.

Daubeny, Charles (1795-1865) Chemist, botanist and geologist

Daubeny was educated at Winchester College in 1808 and 1810, then was elected to a demyship at Magdalen College, Oxford under Dr John Kidd. From 1815 to 1818 he studied medicine in London and Edinburgh and went on to graduate with an MA degree at Oxford and went on to become a fellow of the College of Physicians. Daubeny became a Fellow of the Royal Society.

David, Tennett William Edgeworth (1858-1938) Welsh geologist, Antarctic explorer. In 1870 at the age of 12 years he went to Magdalen College, Oxford. He gained a classical scholarship to New College, Oxford in 1876 and graduated with a BA. David spent two years in field studies of the geology of Wales. In 1882 he briefly studied at the Royal School of Mines, London under Professor J.W. Judd.

Davies, John Langdon (1897-1971) Author and journalist.

Davies came to England from his birthplace Eshowe, South Africa at the age of 6 years to attend Yardley Park Prep School and later Tonbridge School. He entered St. Johns College, Oxford with three scholarships. However, one was removed due to his imprisonment as a conscientious objector during World War I. Due to the removal of another scholarship due to his marriage Davies ended his academia career with a diploma in anthropology and history.

Deacon, Henry (1822-1876) Chemist and industrialist.

Deacon was educated at a Quaker school in Tottenham and was also influenced by the family friend Michal Faraday. Deacon was apprenticed at the age of 14 years to the London engineering firm of Galloway & Sons.

Delane, John Thadeus (1817-1879) Editor

Delane attended a number of private schools and furthered his education at King's College, London. He studied at Magdalen Hall, Magdalen College, Oxford and graduated with a degree in 1840 when he began working for *The Times.*

Dix, Emily (1904-1972) Palaeobotanist

Dix went to the Gowerton Intermediate School, Swansea from 1916 to 1922, and gained distinction in the Junior and Senior Central Welsh Board Certificates. She then obtained a Glamorgan County Scholarship to study at the University College Swansea and studied geology, and subsidiary subjects in botany and pure mathematics. Dix graduated in 1925 with a first-class Honours in geology, specialising in palaeontology. After graduation she stayed at the university college and obtained a M.Sc. in 1926.

Dobbie, James, Johnston (1852-1924) Chemist

Dobbie was educated at Glasgow High School and then went on to Glasgow University graduating with an MA in 1875. He did his postgraduate studies at University of Edinburgh under William Ramsay and received a D.Sc. in 1879. Dobbie was made a Fellow of the Royal Society of Edinburgh in 1903 and a Fellow of the Royal Society in 1904.

Eden, Charles Hamilton (died 1921) Mining engineer.

Hamilton was educated at the College of Physical Sciences at Newcastle-on-Tyne.

Edwards, Charles Alfred (1882-1960) Metallurgist and principal of University College, Swansea.

Information regarding Edwards early life and education is sparse. Edwards' family moved to England from Kitchener, Canada when he was two. In 1898 he was apprenticed to the Lancashire and Yorkshire Railway Works at Horwich, Lancashire, where he spent some years working in the Chemical Laboratory. In 1905 he was appointed as assistant to Sir Harold Carpenter in the Metallurgical Department of the National Physical Laboratory. He was awarded the honour of Doctor of Science without full-time attendance at any higher education institution. Edwards was elected a Fellow of the Royal Society in 1930.

Edwards, Sir Owen Morgan (1858-1920) Man of Letters, Politician

Edwards went to Bala College and between 1880-83 Aberystwyth College. He spent a session at Glasgow University studying philosophy under Edward Caird and in 1884 went on to Balliol College, Oxford and graduated with first-class Honours.

Evans, Evan Jenkin (1882-1944) Physicist and university professor.

Evans received his early education at the county school in Llanelli, South Wales and then enrolled at the University College of Wales, Aberystwyth and graduated in 1902. He then went on to the Royal College of Science at South Kensington, London. He took the Associateship in 1906 and stayed on at Kensington becoming a demonstrator first in astrophysics and then in physics. Evans received the degree of D.Sc. of the University of London in 1915.

Fleure, Herbert John (1877-1969) Zoologist and geographer.

Blindness in one eye and ill health affected Fleure's attendance at the States Intermediate School, Gurnsey between 1885-1891. However, he passed the London matriculation examination in 1894 and the London Intermediate B.Sc. in 1897. Fleure was awarded a scholarship in 1897 to Aberystwyth where he obtained a first-class Honours in zoology in 1901. The University of Wales awarded him a fellowship to study marine biology in Zurich, Switzerland and was awarded a D.Sc. degree (Wales).

Fothergill, Philip Gilbert (1908-1967) Biologist and historian of science.

Fothergill was educated at St. Joseph's College, Dumfries and then attended Durham University. He graduated with a BSc and was awarded a PhD in 1934.

Frankland, Sir Edward (1825-1899) Chemist.

Frankland was educated from the age of 8 at the private school of James Wallasey. From the age of 12 years he attended the Lancaster Free Grammar School. Unable to pursue a career in medicine due to a lack of finance, he was indentured in 1840 by his step-father William Helm as an apprentice to Stephen Ross, a Lancaster pharmacist. During this period Frankland attended classes run by Dr James Johnson at the Lancaster Mechanics Institute. With the support and encouragement of Dr Johnson, Frankland acquired a place at Lyon Playfair's laboratory where he successfully completed the chemistry course and exam. In 1847 he became a full-time student at the University of Marburg, Germany.

Fulton, John Scott, Baron Fulton (1902-1986) University principal and public servant.

Fulton was educated at Dundee High School and then St. Andrews University, Scotland. He entered Balliol College, Oxford and was awarded a second-class Honours in both classical moderations in 1924 and literae humaniores in 1926.

Galloway, Sir William (1840-1927) Scottish mining engineer, professor and industrialist.

Galloway attended a private school in Scotland before going to Germany where he studied at the University of Giessen and Technische Universitat Bergakademi Freiberg. He returned to Britain and studied at the University College of London and later the University of Wales where he obtained an honorary degree DSc.

Gowenlock, Brian Glover (1926-2019) Chemist and university professor.

Gowenlock's early education was at Oldham Hulme Grammar School with the support of a Hulme scholarship. He was awarded a state scholarship to attend the University of Manchester where he obtained a first-class BSc Honours in chemistry in 1946. Gowenlock stayed on at the University of Manchester to undertake postgraduate research and received a MSc in 1947 and a PhD in 1949.

George, David Lloyd (1863-1945) British Liberal statesman and Prime Minister. Lloyd-George grew up in Caernarvonshire and was educated at the local Anglican school, Llanystumdwy National school. His later education was a combination of private tutors and being self-taught and learning Latin and French to qualify for legal training. Lloyd-George undertook articles to a firm of solicitors in Porthmadog and was awarded an Honours in his final law exam in 1884.

George, Thomas Neville (1904-1980) Carboniferous stratigrapher, palaeontologist and university professor.

George began his education in 1907 at the age of 3 years at the Pentrepoeth Infants School in Morriston, Swansea, and at the age of 6 years went on to Morriston Boys' Elementary School where he was taught by his father. At the age of 10 years he obtained a scholarship to Swansea Municipal Secondary School (later Dynevor School). In 1919 George obtained a 1st class in the Oxford local Senior Certificate where he took eight subjects and transferred to the sixth form at Swansea Grammar School. Unable to afford to go to Oxford or Cambridge he was the first Senior Scholar of the University College, Swansea and entered the science faculty in 1920 at the young age of 16 years. In 1921 he passed Intermediate B.Sc. (Wales) and Intermediate B.Sc. (London). In 1924 he was the first student to graduate from the institution with B.Sc. (Wales) Honours in geology. George was awarded an Eyton Williams studentship and a university postgraduate award and achieved a M.Sc. (Wales) in 1925. He studied at St. John's College, Cambridge and obtained his Ph.D. degree in 1928. George was made a Fellow of the Royal Society in 1963.

Gilbertson, Francis William (1873-1929) Industrialist and first president of the University College of Swansea.

From the age of 13 years Gilbertson spent two years at the Charterhouse School in Godalming. In 1891 he went to Magdalen College, Oxford University to read natural sciences with chemistry as a specialism. Gilbertson graduated with a degree in 1894.

Gilchrist, Douglas Aston (1860-1927) Professor of Agriculture and government advisor.

Gilchrist attended the Hamilton Academy School in South Lanarkshire. He then spent 12 years in practical farming before attending agriculture and science classes at the Glasgow Technical College. Gilchrist furthered his studies at the University of Edinburgh and graduated in 1889 with a BSc in agriculture. Gilchrist was also awarded the Royal Agricultural Society of England's senior certificate and the Highland Agricultural Society of Scotland's diploma in agriculture.

Griffiths, Ernest Howard (1851-1932) Principal and Physicist

Griffiths early education was in Manchester. He entered Jesus College, Oxford where he was made a Fellow of the college. Griffiths was made a Fellow of the Royal Society in 1895.

Haber, Fritz (1868-1934) German chemist.

Haber attended primary school at Johanneum School, and in 1886 at the age of 11 years he went to St. Elizabeth High School, Breslau. Haber studied chemistry at the Friedrich Wilhelm University in Berlin. After attending Heidelberg University for the summer semester of 1887 Haber to Berlin where he enrolled at the Technical College of Charlottenburg. He later received his doctorate from Friedrich Wilhelm University in 1891. In 1918 Haber received the Nobel Prize for his invention of the Haber-Bosch process.

Haldane, Richard Burdon, 1st Viscount Haldane (1856-1928) Labour politician, lawyer, philosopher and Secretary State for War.

Haldane was first educated at Edinburgh Acadfinal emy and then went to the University at Göttingen, Germany. He later gained a first-class degree and an MA at the University of Edinburgh. He was called to the bar at Lincoln's Inn in 1879.

Harper, John Lander (1929-2009) Biologist and university professor.

Harper attended Laurence Sheriff School, Rugby. He then went on to Oxford University where he achieved a degree in Botany in 1946. Harper remained at Oxford and was awarded an MA and later in 1950 a DPhil.

Hartley, Harold B (1878-1972) Physical chemist.

Hartley was educated at Dulwich College and later at Balliol College, Oxford University where he achieved a first in natural science. Harley was made a Fellow of the Royal Society in 1926.

Hassall, Cedric (1919-2017) Chemist and university professor.

Hassall was educated at Auckland Grammar School, New Zealand. He then went on to study at Auckland University College where he graduated with a MSc in 1942. Before emigrating to Britain Hassall completed a course at Auckland Teachers' Training College. He then attended University of Cambridge and was awarded a PhD in chemistry in 1945.

Henderson, Arthur (1863-1935) Iron moulder and Labour politician, leader of the Labour Party.

Henderson's family was extremely disadvantaged and there is no mention of an early education. He was apprenticed at the age of 12 years at the Robert Stephenson & Sons General foundry.

Herschel, John (1792-1871) Polymath, mathematician, astronomer, chemist and inventor.

Herschel was educated at Eton College and went on to St. Johns College, Cambridge where he graduated in 1813. In the same year he was elected a Fellow of the Royal Society.

Hogg, Quintin, Baron Hailsham of St. Marylebone (1907-2001) Barrister and conservative politician.

Hogg was educated at Eton College where he was a King's Scholar. He won the Newcastle Scholarship in 1925 and entered Christ Church, Oxford where he obtained a first in Honours Moderations in 1928 and in *Literae Humaniores* in 1930. Hogg was elected to a prize Fellowship in Law at All Souls College, Oxford in 1931 and was called to the bar at Lincoln's Inn in 1932.

Humboldt, William von (1767-1834) Philosopher, linguist, founder of the Humboldt University of Berlin.

Humboldt was privately tutored at the family estate in Tiegel. His tutors were recruited from leading figures of the Berlin Enlightenment scene, such as Joachim Heinrich Campe and the renowned philosopher and writer Jakob Engel. After one semester at the provincial Prussian university at Frankfurt an der Oder, Humboldt transferred in 1788 to the University of Göttengen, where he studied classical philosophy and natural sciences.

Huxley, Thomas (1825-1895) Biologist and Anthropologist.

Due to family financial difficulties Huxley left school at the age of 10 after completing only two years of formal schooling at the Great Ealing school. Huxley taught himself subjects such as geology, Latin and Greek and became fluent in German, and was self-taught expert on invertebrates and vertebrates. His skill at anatomical drawings enabled him to illustrate his academic work.

Hyde, Harold Augustus (1892-1973) Botanist and palynologist.

Hyde attended Northgate School, Ipswich and went on to Downing College, Cambridge.

Jones, Dora Herbert (1890-1974) Administrator and singer.

Jones was educated at the Llangollen County School and then proceeded to the University College of Aberystwyth to study Welsh. She graduated in 1912 and took a year course in palaeography.

Jones, Sir Henry (1852-1922) Welsh philosopher and academic.

Jones was apprenticed to his father, a shoemaker in Llangernyw, and later studied at Bangor Normal College. He entered the University of Glasgow to study for the ministry. However, after graduating he studied at Oxford University and in Germany.

Jones, John Viriamu (1856-1901) Physicist and Educationalist.

Jones had a Welsh background whose family moved to London. He was educated at a private school in Reading and the University College School in London. When his family moved back to Wales, he continued his education at the Normal College, Swansea. He entered the University College of London aged 16 years. In 1874 Jones won a scholarship to Balliol College, University of Oxford where he obtained a first-class Honours in mathematics and physics.

Jones, Thomas (1870-1955) Civil servant and educationalist.

Jones was educated at the Upper Rhymney School and Lewis School in Penglam, Monmouthshire. In 1890 he won the Calvinist Methodist scripture gold medal and went to the University College of Wales at Aberystwyth to study for the ministry. While there he changed direction and graduated with a first-class Honours in economics from the University of Glasgow in 1901.

Kastner, Leslie James (1911-1996) Engineer and university professor.

Kastner was educated at Highgate School and later went to Clare College, Cambridge where he took the mechanical sciences tripos in 1934.

King, William Bernhard Robinson (1889-1963) Geologist.

King graduated from Jesus College, Cambridge University in geology.

Knight-Jones, Elis Wyn (1916-2012) Marine biologist and university professor.

Knight-Jones started his education in 1922 when he attended Oakland House School, Blackheath, London. He then went on to Clanricarde House School, Sutton and in 1926 moved to Fonthill Preparatory School, East Grinstead, Surrey. Knight-Jones continued his education at Epson College before entering the University College of Bangor, North Wales where he received a first-class Honours in Zoology. He was then awarded a Meyricke Scholarship to study at Jesus College, Oxford, however World War II disrupted his studies. In 1946 he resumed his studies with the aid of a grant from the Ministry of Agriculture and Fisheries and completed his D.Phil.

Knox, John (1927-2018) Physical Chemist and university professor.

Knox attended George Watsons College, Edinburgh and then went on to the University of Edinburgh where he obtained a first-class Honours in Chemistry in 1949. Knox was awarded a Carnegie Research Studentship to attend Pembroke College, Cambridge as a PhD student.

Lewis, David Thomas (1909-1992) Chemist, university lecturer and government chemist.

Lewis went to a county school at Brynmawr in Breconshire and then went on to the University College of Aberystwyth. He achieved a first-class Honours in chemistry and remained at the institution to research for a PhD under the supervision of Lawson John Huddleston.

Leighton, Arthur Edgar (1873-1961) Chemical engineer, administrator.

Leighton was educated at Westminster Wesleyan Training College and the Birbeck Literary and Scientific Institution.

Leitch, Duncan (1904-1956) Geologist and palaeontologist.

Leitch attended Woodside School in Glasgow, Scotland. He later studied science at Glasgow University and graduated with a first-class Honours in geology in 1926 and became a student demonstrator in geology assisting Professor John Walker Gregory. In 1946 he was elected as a Fellow of the Royal Society of Edinburgh.

Liebig, Justus von (1803-1873) Chemist.

Leibig attended the grammar school, the Ludwig-Georgs-Gymnasium in Darmstadt, Germany from the age of 8 to 14 years, and left with a certificate of completion. He was apprenticed to the apothecary Gottfried Pirsch in Heppenheim. Leibig attended the University of Bonn and then the University of Erlangen where he graduated with a PhD.

Llewellyn-Jones, Frank (1907-1997) Physicist and principal of University College of Swansea.

Llewellyn-Jones received his early education at West Monmouth School, South Wales. In 1925 he went to Merton College, Oxford as an Open Science Exhibitioner and obtained a first in physics in 1929. He was then awarded a research scholarship as Senior Demy at Magdalen College and completed his DPhil as a research student of Professor Sir John Townsend at the Clarendon Laboratory, Oxford University.

Lowe, Robert, 1st Viscount Sherbrooke (1811-1892) Statesman, Chancellor of the Exchequer.

Lowe had albinism which affected his eyes so badly he was initially considered unfit for school. However, in 1822 he went to a school at Southwell, Risley, and entered Winchester University College, Oxford in 1825. Lowe then won a fellowship at Magdalen College and obtained a first-class degree in Literae Humaniores.

Maddock, Ieuan (1917-1988) Physicist and university professor.

Maddock attended his local primary school at Gorseinon, South Wales and then went on to Gowerton Grammar School for boys. He obtained a scholarship to the University College of Swansea. Maddock achieved a first-class Honours in Physics. His research on optical measurements for a PhD were disrupted by World War II. Maddock joined the Government Department of Explosives Research and Development as an experimental officer when the department was evacuated to the University College of Swansea in 1940.

Margerison, Tom (1923-2014) Broadcaster and journalist.

Margerison was a boarder at Huntingdon Grammar School, Hymers College, Hull and then went on to attend King's School at Macclesfield. He entered Sheffield University where he took a PhD in Physics.

McCormick, Sir William (1859-1930) Scottish scholar and educational administrator.

McCormick was educated at Dumfries High School and then went on to Glasgow University where he graduated with an MA in 1880. Later he travelled to Germany and attended the universities of Göttingen and Marburg to study literature.

Mill, John Stuart (1806-1873) Philosopher, political economist and civil servant.

Mill was educated by his father, the Scottish philosopher, historian and economist, James Mill, with the assistance of Jeremy Bentham and Francis Place. At the age of 3 Mill was taught Greek and had read the Classics, learnt Latin and algebra by the age of 10. As he was not eligible to attend Oxford or Cambridge Universities, Mill went to the University College of London. In 1856 he was elected a Foreign Honorary member of the American Academy of Arts and Sciences.

Mockeridge, Florence Annie (1889-1958) Botanist and university professor.

Mockeridge's early education is not documented, but her secondary education was at Woolwich Polytechnic. She then attended King's College, London as a Merchant Taylor's Company Scholar and graduated with a 1st class honours in the Pass B.Sc. in 1909. Mockeridge was awarded an Honours B.Sc, in 1910 with the Carter Gold Medal of King's College. She continued research with Professor W. B. Bottomleyas a Layton Research Student from 1911-1917 and was awarded the D.Sc.

Mond, Dr Ludwig (1839-1909) Chemist and industrialist.

Mond attended schools in his hometown of Kassel, Hesse, Germany. He studied chemistry at the University of Marburg under Hermann Kolbe and University of Heidelberg under Robert Bunsen but did not gain a degree.

Mond, Sir Alfred (1868-1930) Industrialist, financier and politician.

Mond was the son of Ludwig Mond and educated at Cheltenham College and St. John's College, Cambridge, but he failed his natural science tripos. He went on to study law at the University of Edinburgh and was called to the bar at the Inner Temple in 1894.

Morgan, E. Victor (1915-1996), Economist and university professor.

Morgan was born with exceptionally poor eyesight which hampered his early schooling, and consequently, he was home-schooled by his mother who was a teacher. He later attended Warwick School, Warwick. Morgan entered Sidney Sussex College, Cambridge to study economics.

Murphy, A. J. (n.d.) Metallurgist, university professor and principal.

Murphy graduated from Manchester University in 1920 with first-class Honours in chemistry.

Neild, Alfred (1822-1906) Chemist and university treasurer.

Neild was educated at the Friend's Grove House School in Tottenham and later studied chemistry at the University College of London.

Newman, John Henry (1801-1890) Theologian, poet, Anglican priest and later a Roman Catholic priest and cardinal.

Newman went to Great Ealing school where Thomas Huxley's father taught mathematics. Newman then went on to Trinity College, Oxford, but only graduated with a 'low' BA and failed the classification in mathematics. Wishing to remain at the college Newman took on private pupils and read for a fellowship at Oriel College, Oxford.

Nicholas, Dr Thomas (1816-1879) Congregational minister, theological college tutor, historian, promoter of higher education in Wales.

Nicholas was brought up at Troed-y-rhiw, near Trefgarn Chapel, Solva, Pembrokeshire. He continued with his education at Lancashire College, Manchester. Nicholas went on to Göttingen University, Germany where he was awarded an MA and a PhD.

Norrish, Ronald George Weyford (1897-1978) Chemist and university professor.

Norrish attended The Perse School, Cambridge where he was awarded a scholarship to study at Emmanuel College, Cambridge. He obtained a double first in the Natural Science and continued at Cambridge to research his PhD.

Osler, Sir William (1849-1919) Canadian Physician.

Osler was educated at the Trinity College School, Weston, Ontario and later entered Trinity College, Toronto to study for the ministry. He then changed career direction and entered Toronto School of Medicine which he left after accepting an offer to the MDCM program at McGill University Faculty of Medicine in Montreal. Osler received a medical degree in 1872 and did his postgraduate training under Rudolf Virchow in Europe.

Owen, Sir Henry (1804-1881) Educationalist, pioneer of higher education in Wales.

Owen was educated at a school kept by Evan Richardson in the village of Llangeinwen on the island of Anglesey, Wales. Trained as a clerk in London.

Parry, John Horace (1914-1982) Maritime historian, university professor and administrator.

Parry attended King Edward School, Birmingham. He continued his education at Clare College, Cambridge where he studied history and was awarded a PhD in 1938.

Peacock, George (1791-1858) Mathematician.

Peacock was home schooled by his father, then went to Sedbergh school. At age 17 he was sent to Richmond School under James Tate and was admitted to Trinity College, Cambridge in 1809. Peacock went on to become a fellow and then a lecturer of the college and was elected a Fellow of the Royal Society in 1818.

Penny, William George (1909-1991) Mathematician and university professor.

Penny went to Sheerpess Technical School for boys in Kent between 1924-26. In 1927 he gained a scholarship to study science at Imperial College Faculty of Natural Science. Penny graduated with a BSc first-class Honours in mathematics and an MSc in 1931. He took a research position at the London University in 1932 to research for a PhD in mathematics.

Pfiel, Leonard Bessemer (1898-1969) Metallurgist.

Pfiel was educated at St Dunstan's College, Catford, London. He left school during the 1914-1918 war and was employed as a metallurgical chemist as well as attending evening classes at numerous London teaching institutions. After demobilisation he attended the Royal School of Mines and graduated with B.Sc. in 1921 with a first-class Honours and won the Bessemer Medal and the Murchison Medal. Piel received the degree of Doctor of Science of the University of London in 1927 for his research undertaken at the University College of Swansea. Pfiel was elected a Fellow of the Royal Society in 1951.

Playfair, Lyon, 1st Baron Playfair (1818-1898) Scientist and liberal politician.
Playfair was born at Chunar, Bengal, India and was sent to Scotland to be educated at the University of St. Andrews and then the Andersonian Institute in Glasgow. His university education was at the University of Edinburgh. Playfair became the private laboratory assistant to the chemist, Thomas Graham at the University College of London and in 1839 went to work under Justus Liebig at the University of Giessen, Hesse, Germany. In 1859 Playfair was elected as a Fellow of the Royal Society.

Purnell, Howard (1925-1996) Chemist and university professor.
Purnell was educated in local schools in the Rhondda, South Wales and continued his education at the University College of Cardiff and graduated with a First-class degree in Chemistry in 1946. He went back to academia in 1952 when he entered the University of Cambridge to study for another PhD under Professor R.G.W. Norrish, head of Physical Chemistry.

Raisin, Catherine (1855-1945) Geologist
Raisin was educated at the North London Collegiate School, a private school for girls. At the age of 18 years she attended classes at University College London where she first studied geology, then mineralogy. In 1877 Raisin achieved a special certificate in botany but could not study for a degree until courses were open to women in 1878. In 1879 she passed the Intermediate Science examination studying geology, botany and zoology. Raisin was the first woman to study geology at the University College London and obtained a B.Sc. honours in both geology and zoology. In 1898 she was finally able to receive her D.Sc. from the University of London. Raisin was the second female geologist to become a Doctor of Science.

Robertson, Sir Robert (1869-1949) Chemist and HM Government's government chemist.
Robertson was educated at Bell Baxter School in Fife, Scotland. He later attended St. Andrew's University where he graduated in both Arts and Science.

Rosebery, Archibald Primrose, 5th Earl (1847-1929) Liberal politician and M.P.
Roseberry attended prep schools in Hertfordshire and Brighton, and then went to Elton College. He proceeded to Christ Church College, Oxford where he graduated in 1866.

Rutherford, Ernest (1871-1937) Physicist.

Rutherford received his early education in Government Schools in his hometown of Nelson, New Zealand and at the age of 16 years entered Nelson Collegiate School. In 1889 he won a scholarship to Cambridge College, University of New Zealand and graduated with an MA in maths and physical sciences. Rutherford continued at the college and received a B.Sc. in 1894. The same year he was awarded an 1851 Exhibition Science Scholarship which he used to study at the Cavendish laboratory at Trinity College, Cambridge. Rutherford studied under J.J. Thompson. In 1897 he was awarded a BA Research Degree and a Loutts-Trotter studentship of Trinity College. Rutherford was awarded the Nobel Prize for Chemistry in 1908.

Samuelson, Bernhard (1865-1895) Industrialist, educationalist and Liberal politician and M.P.

Although born in Hamburg, Germany Samuelson attended the Reverend J. Blezard's school at Skirlaugh, Yorkshire. At the age of 14 years he started work at the office of his father's merchant business.

Schleiermacher, Friedrich E. D. (1768-1834) German theologian, philosopher and biblical scholar.

Schleiermacher started his education in a Moravian school at Niesky, Upper Lusatia and at Barby near Magdeburg. He then entered the University of Halle to study theology.

Schott, George Adolphus (1868-1937) Mathematician**.**

Schott was educated at the Bradford Grammar School and later Trinity College, Cambridge where he studied the Natural Science Tripos. He received a BA in 1890 and a D.Sc. degree at the University of London. Schott became a Fellow of the Royal Society in 1922.

Seeley, Harry Govier (1839-1909) Palaeontologist.

Seeley attended classes at the Royal School of Mines and was admitted to the British Museum Library as a Reader. After three years at the library he matriculated as a student to Sidney Sussex College, Cambridge in 1863.

Shoppee, Charles (1904-1994) Organic chemist and university professor.

Shoppee went to the Stationers' Company's School in London. He later went to Imperial College (Royal College of Science).

Sibly, Sir Thomas Franklin (1883-1948) Geologist and university administrator.

Sibly was educated at Wycliffe College, Gloucestershire which had been founded by his uncle, and then at St Dunstan's Burnham-on-Sea. He then went on to study at the University College, Bristol where he obtained first-class Honours in experimental physics (external candidate at London University). Sibly was awarded an 1851 Exhibition scholarship to undertake postgraduate research in Geology and was awarded a degree of DSc in 1908.

Simpson, Brian (d. 1982) Geologist.

Simpson was schooled in Yorkshire and then studied at Liverpool University where he was awarded an M.Sc. degree in geology.

Smith-Rose, Reginald Leslie (1894-1980) Physicist.

Smith-Rose was educated at Llatymer Upper School, London. In 1912 he went to Imperial College supported by a Board of Education royal scholarship. Smith-Rose graduated with a first-class Honours degree in physics and undertook postgraduate research while working at the National Physical Laboratory. He was awarded his PhD in 1923 and his DSc in 1926.

Spencer, Herbert (1820-1903) Philosopher, biologist, anthropologist, sociologist, classical liberal political theorist.

Spencer was educated at his father's school which was run on the progressive teaching methods of Johann Heinrich Pestalozzi. His uncle the Reverend Spencer added to his limited formal education with mathematics, physics and basic Latin. As an autodidact Spencer's later education came from friends and acquaintances.

Taverner, Leonard (1893-1987) Metallurgist and university professor.

Taverner matriculated in England but continued his education at the École de Commerce at Neuchatel, Switzerland where he became fluent in French. He returned to London and studied metallurgy at the Royal School of Mines.

Thonemann, Peter Clive (1917-2018) Physicist and atomic researcher.

Thonemann attended Melbourne Grammar School, Melbourne, Australia and in 1936 entered University of Melbourne to study physics. World War II interrupted his studies and in 1944 he was able to undertake an MA in science. Thonemann continued his research in Britain at Oxford University where he was awarded a DPhil.

Todd, Sir Alexander (1907-1997) Biochemist and university professor.

Todd was educated at Allan Glen's school in Glasgow and went on to Glasgow University where he obtained a BSc degree in 1928. After undertaking short research training with T. S. Patterson, he entered the University of Frankfurt. At Frankfurt Todd studied under Professor Walther Borsche and was awarded a PhD in 1931 for a thesis on the chemistry of the bile acids. Todd returned to Britain and contined his research at Oxford University where he was awarded a PhD in 1933.

Trueman, Arthur Elijah (1894-1956) Geologist and university professor.

In 1906 Trueman gained a scholarship to High Pavement School in Nottingham and studied there for five years, and where he passed the Intermediate B.Sc. Examination of the University of London. He left the High Pavement School in 1911 and became a student teacher at Huntingdon High School in Nottingham. A year later he entered University College, Nottingham where he was supported by a grant as a teacher in training. This training was done concurrently with his studies for the B.Sc. Trueman obtained his Teacher's Certificate in 1914, the same year he graduated with a first-class Honours in geology with palaeontology as his specialist subject. From 1914 to 1917 he worked with Professor H. H. Swinnerton as a research student and demonstrator at Nottingham. In 1916 Trueman was awarded the M.Sc. of the University of London and in 1918 the D.Sc. Trueman was made a Fellow of the Royal Society in 1942.

Wild, John Paul (1923-2008) Australian scientist.

At the age of 7 years Wild was boarded at the Ardingly College, Sussex. He then went on to the Limes Prep School, Croydon and its associated senior independent school, Whitgift School. In 1942 he entered Peterhouse College, Cambridge to study mathematics. Due to wartime conditions he only completed five terms but was awarded a BA and later an MA. Ten years later and a further two years of deliberations of his research the University of Cambridge awarded him the degree of Doctor of Science.

Williams, David Trevor (1898-1984) Geologist.

Williams studied civil engineering at the University of Liverpool. However, he changed his studies to geology and received his PhD at Liverpool.

Williams, Evan James (1903-1945) Scientist

Williams attended the primary school at Llanwenog, Wales and proceeded to the county school at Llandysul. He then entered the University College of Swansea and graduated with a first-class Honours in physics. Williams undertook his post-graduate research at the University College of Swansea, University of Manchester and Cambridge University. He obtained the degrees of PhD (Manchester), PhD (Cambridge), DSc (Wales) by 1930.

Williams, Thomas Jeremiah (1872-1919) Barrister and Welsh liberal politician

Williams went to the University College School, London and then went on to the Sheffield Technical College and Firth College.

William Whewell (1792-1866) Polymath, scientist, philosopher and historian of science.

Whewell was educated at Lancaster and then Heversham grammar schools, and in 1812 won a scholarship at Trinity College, Cambridge. Later he became a fellow and tutor of the college and in 1841 succeeded Christopher Wordsworth as master of Trinity College.

Wilson, Harold (1916-1995) Labour politician and prime minister.

Wilson won a scholarship to attend Royds Hall Grammar School, Huddersfield, Yorkshire. When his family moved to Spital, Cheshire, Wilson was educated at the sixth form at Wirral Grammar School for boys. With financial support in the form of grants he entered Jesus College, Oxford in 1934 and graduated with a first-class degree in PPE, (philosophy, politics and economics). He continued in academia becoming one of the youngest Oxford dons of the 21st Century at the age of 21 years.

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